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Arizona Corporation Commission

DOCKETED

JAN 30 2015

January 30, 2015

Docket Control  
Arizona Corporation Commission  
1200 West Washington  
Phoenix, Arizona 85007



ORIGINAL

RE: Arizona Public Service Company Ten-Year Transmission System Plan  
Docket No. E-00000D-15-0001

In compliance with A.R.S. § 40-360.02, enclosed please find Arizona Public Service Company's ("APS") 2015-2024 Ten-Year Transmission System Plan for major transmission facilities (Attachment A), which includes the internal planning criteria and system ratings as required by Arizona Corporation Commission ("ACC") Decision No. 63876 (July 25, 2001) and the Renewable Transmission Action Plan (Attachment B).

IT IS FURTHER ORDERED that Transmission Owners are required to file, with their Ten-Year Plans, internal planning criteria and systems rating with limiting elements identified. (Decision No. 63876, p.3).

The 2015-2024 Ten-Year Plan describes planned transmission lines of 115 kV or higher that APS may construct over the next 10 years. This Ten-Year Plan includes approximately 191 miles of new 500 kV transmission lines, 78 miles of new 230 kV transmission lines, 6 miles of new 115 kV transmission lines, and 8 new bulk transformers. These new transmission projects, coupled with additional distribution and sub-transmission investments, will support reliable power delivery in APS's service area, Arizona, and in the western United States.

If you have any questions regarding this information, please contact Gregory Bernosky at (602)250-4849.

Sincerely,

Lisa Malagon

LM/sb

cc: Janice Alward  
Steve Olea  
John Foreman  
Brian Bozzo  
Terri Ford

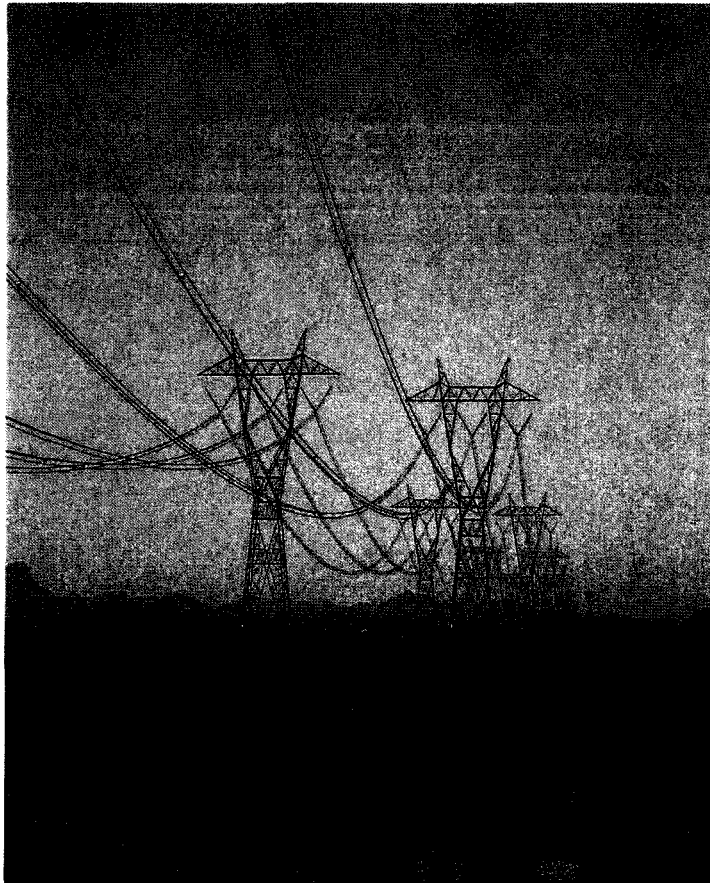
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# Attachment A



**ARIZONA PUBLIC SERVICE COMPANY  
2015–2024  
TEN-YEAR TRANSMISSION SYSTEM PLAN**

Prepared for the  
Arizona Corporation Commission



January 2015

# ARIZONA PUBLIC SERVICE COMPANY 2015 - 2024 TEN-YEAR TRANSMISSION SYSTEM PLAN

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**ARIZONA PUBLIC SERVICE COMPANY  
2015–2024  
TEN-YEAR TRANSMISSION SYSTEM PLAN**

**GENERAL INFORMATION**

Pursuant to A.R.S. § 40-360.02, Arizona Public Service Company (“APS”) submits its 2015–2024 Ten-Year Transmission System Plan (“Ten-Year Plan”). Additionally, pursuant to Arizona Corporation Commission (“Commission”) Decision No. 63876 (July 25, 2001) concerning the First Biennial Transmission Assessment (“BTA”), APS is including with this filing its Transmission Planning Process and Guidelines and maps showing system ratings on APS’s transmission system. The Transmission Planning Process and Guidelines generally outline APS’s internal planning for its high voltage (“HV”) and extra-high voltage (“EHV”) transmission system, including a discussion of APS’s planning methodology, planning assumptions, and its guidelines for system performance. The system ratings maps show continuous and emergency system ratings on APS’s EHV system, and on its Metro, Northern, and Southern 230kV systems. APS also includes its Renewable Transmission Action Plan as an attachment to this filing. The Ten-Year Plan is conducted and filed annually with the Commission.

This Ten-Year Plan describes planned transmission lines of 115kV or higher voltage that APS may construct or participate in over the next ten-year period. Pursuant to A.R.S. § 40-360(10), underground facilities are not included. There are approximately 191 miles of 500kV transmission lines, 78 miles of 230kV transmission lines, 6 miles of 115kV transmission lines, and 8 transformers contained in the projects in this Ten-Year Plan. The total investment for the APS projects and the anticipated APS portion of the participation projects as they are modeled in

this filing is estimated to be approximately \$285 million.<sup>1</sup> Table 1 provides an overview of the projects included in this Ten-Year Plan.

**Table 1: Ten Year Plan Project Breakdown**

<b><u>Description</u></b>	<b><u>Projects in Ten-Year Plan</u></b>
<b>500kV transmission lines</b>	191 miles
<b>230kV transmission lines</b>	78 miles
<b>115kV transmission lines</b>	6 miles
<b>Transformers</b>	8
<b>Total Investment</b>	\$285 million <sup>1</sup>

Consistent with the Commission's Sixth BTA (Decision No. 72031, December 10, 2010) this Ten-Year Plan includes information regarding planned transmission reconductor projects, substation transformer replacements, and reactive compensation projects. At this time, APS does not have any plans for reconductoring any existing transmission lines. These types of plans often change as they typically are in direct response to load growth or generator interconnections. Therefore, in-service dates for transformer replacement/additions and transmission reconductor projects change to reflect the load changes in the local system. Also, there may be projects added throughout the course of the planning year to accommodate new generator interconnections. Table 2 shows a list of the planned substation transformer additions/replacements.

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<sup>1</sup> This value is not comparable to the Capital Expenditures table presented in the "Liquidity and Capital Resources" section of APS's 10-K filing, which also includes other transmission costs for new subtransmission projects (69kV) and transmission upgrades and replacements.

**Table 2: Equipment Additions/Replacements**

<b><u>Description</u></b>	<b><u>Year</u></b>
Two 100MVAR Reactors at Four Corners 230kV	2015
Trilby Wash 230/69kV Transformer	2015
Sun Valley 500/230kV Transformer	2016
Mazatzal 345/69kV Transformer	2017
Prescott 230/115kV Transformer #3	2017
North Gila 500/230kV Transformer	2018
Orchard 230/69kV Transformer	2018
Orchard 230/69kV Transformer #2	2018
Saguaro 230/69kV Transformer	2021

Some of the facilities reported in prior Ten-Year plan filings have been completed. Others have been canceled or deferred beyond the upcoming ten-year period and are not included in this Ten-Year Plan. The projects that have “To Be Determined” in-service dates are projects that have been identified, but are either still outside of the ten-year planning window or have in-service dates that have not yet been established. They have been included in this filing for informational purposes. A summary of changes from last year’s Ten-Year plan is also provided. Additionally, a section is included that briefly describes projects still in the feasibility planning phase.

For convenience of the reader, APS has included planned transmission maps showing the electrical connections and in-service dates for all overhead transmission projects planned by APS for Arizona (p.8), the Phoenix Metropolitan Area (p.9), and the Yuma area (p.10). Written descriptions of each proposed transmission project are provided on subsequent pages in the currently expected chronological order of each project. The line routings shown on the system

maps and the descriptions of each transmission line are intended to be general, showing electrical connections and not specific routings, and are subject to revision. Specific routings are recommended by the Arizona Power Plant and Transmission Line Siting Committee and ultimately approved by the Commission when issuing a Certificate of Environmental Compatibility (CEC) and through subsequent right-of-way acquisition. Pursuant to A.R.S. § 40-360.02(7), this filing also includes technical study results for the projects where construction dates have been identified. The technical study results show project needs that are generally based on either security (contingency performance), adequacy (generator interconnection or increasing transfer capability), or both.

APS participates in numerous regional planning organizations. Through membership and participation in these organizations, the needs of multiple entities, and the region as a whole, can be identified and studied, which maximizes the effectiveness and use of new projects. Regional organizations in which APS is a member include the Western Electricity Coordinating Council ("WECC"), the Southwest Area Transmission Planning ("SWAT"), and WestConnect. The plans included in this filing are the result of these coordinated planning efforts. APS provides an opportunity for other entities to participate in future planned projects.

The Commission's Sixth BTA ordered that utilities include the effects of distributed generation and energy efficiency programs on future transmission needs. APS's modeled load, located in the Technical Study Report section of this filing, addresses these effects.

Consistent with the Commission's Decision in the Seventh BTA, (Decision No. 73625, December 12, 2012), APS continues to monitor the reliability in Cochise County and, if applicable, will propose any appropriate modifications in future ten-year plans.

The projects identified in this Ten-Year Plan, with their associated in-service dates, will ensure that APS's transmission system meets all applicable reliability criteria. Changes in regulatory requirements, regulatory approvals, or underlying assumptions such as load forecasts,

generation or transmission expansions, economic issues, and other utilities' plans, may substantially impact this Ten-Year Plan and could result in changes to anticipated in-service dates or project scopes. Additionally, future federal and regional mandates may impact this Ten-Year Plan specifically and the transmission planning process in general. This Ten-Year Plan contains tentative information only and is subject to change without notice at the discretion of APS (A.R.S. § 40-360.02(F)).

### **CHANGES FROM 2014-2023 TEN-YEAR PLAN**

The following is a list of projects that were removed or changed from APS's January 2014 Ten-Year Plan filing, along with a brief description of why the change was made:

- Bagdad 115kV line relocation has been advanced from 2017 to 2015 to accommodate Freeport McMoRan's current construction schedule.
- Scatter Wash 230/69kV substation has been moved from 2021 to a "To Be Determined" in-service date based on forecasted load growth in the area near the Scatter Wash Substation.
- The Jojoba 230/69kV substation is now referred to as the Komatke 230/69kV substation to reflect the name change of the land owned by APS.
- The Ocotillo 230kV Generation Interconnections project is now referred to as the Ocotillo Modernization Project to reflect the project name used in the CEC documentation (Decision No. 74812, dated November 13, 2014).

**Table 3: In-Service Date Changes**

<b><u>Project Name</u></b>	<b><u>Previous In-Service Date</u></b>	<b><u>New In-Service Date</u></b>
Bagdad 115kV Line Relocation	2017	2015
Scatter Wash 230/69 kV Substation	2021	TBD

The in-service dates shown in this table are based on factors such as load projections, scope changes, etc., not potential interconnections. New generation interconnections may accelerate the in-service date.

**NEW PROJECTS IN THE 2015-2024 TEN-YEAR PLAN**

There are no new projects planned within the 2015-2024 Ten-Year Plan that were not in the 2014-2023 Ten-Year Plan. The Ocotillo Modernization Project was not included in APS's Ten-Year Plan filed in January 2014, but a supplemental filing was made for the project on May 13, 2014 in Docket No. E-00000D-13-0002.

**CONCEPTUAL PROJECTS IN THE FEASIBILITY PLANNING PHASE**

**Palo Verde/Gila Bend Area To Valley Transmission Capacity**

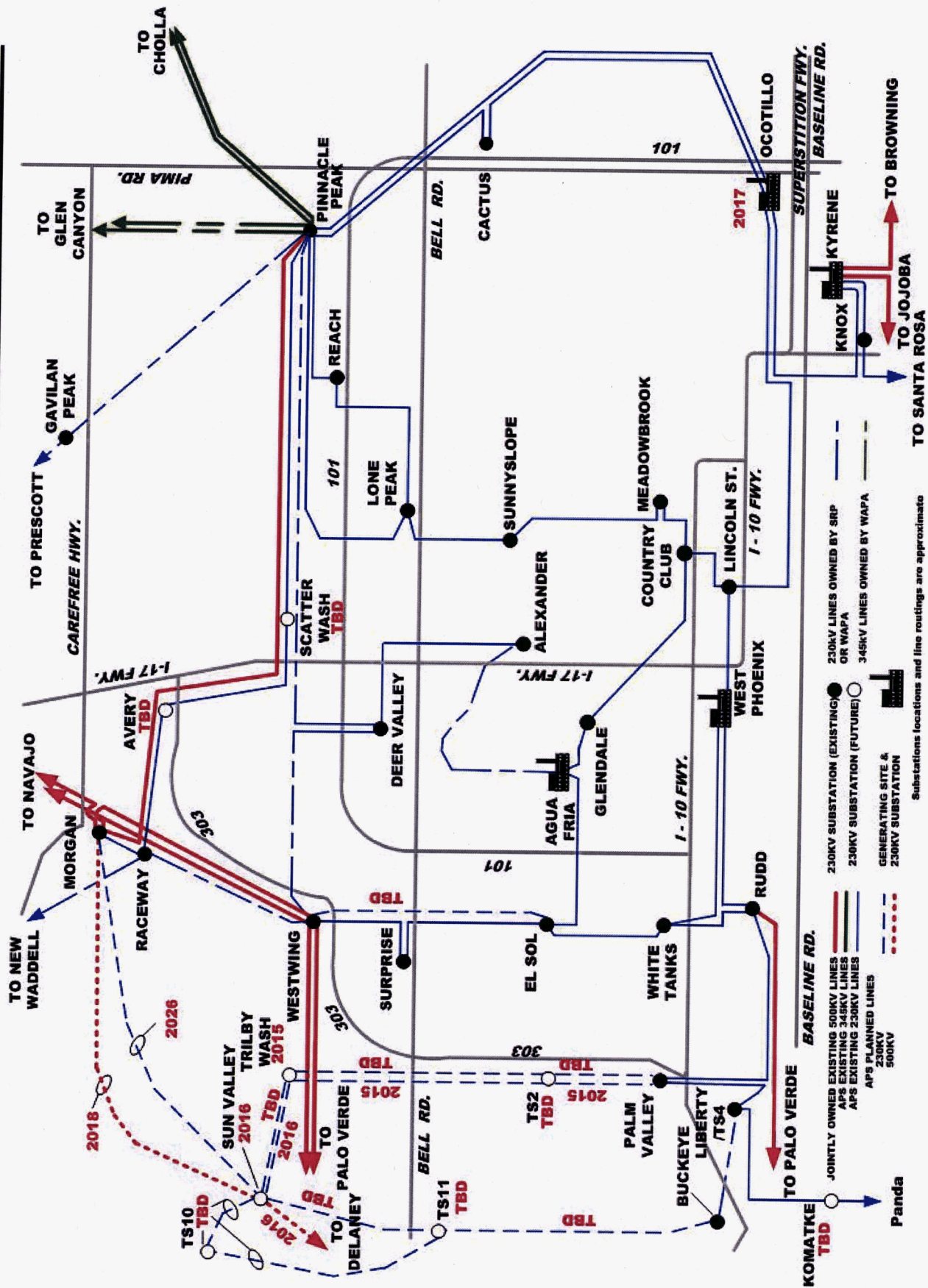
Additional transmission capacity will be studied from the Palo Verde/Gila Bend areas to the Phoenix load center. This transmission capacity is a robust component of the overall APS transmission and resource need. The areas around and west of Palo Verde as well as the Gila Bend area contain some of the best solar resources in the country. These areas also provide access to existing gas resources and, in the case of Palo Verde, potential new gas resources and market purchases.

**PLANNED TRANSMISSION MAPS**

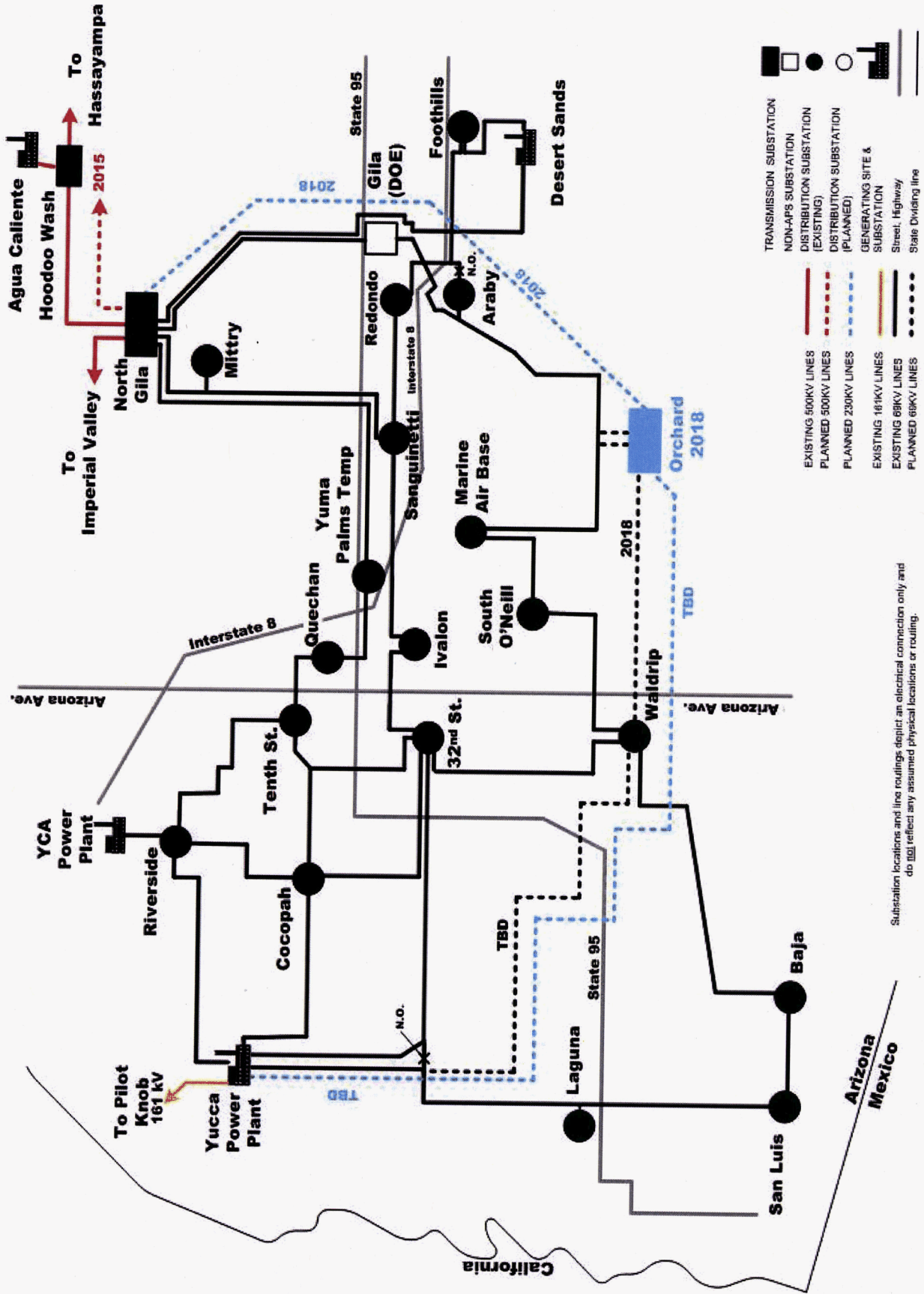




# PHOENIX METROPOLITAN AREA TRANSMISSION PLANS 2015-2024



# Yuma Area Transmission Plans 2015-2024



**PROJECT DESCRIPTIONS**

**Arizona Public Service Company  
2015 – 2024  
Ten-Year Plan  
Planned Transmission Description**

**2015**

**Project Name** Hassayampa – North Gila 500kV #2 Line

**Project Sponsor** Arizona Public Service Company

**Other Participants** Imperial Irrigation District (IID)

**Size**

- (a) Voltage Class 500kV AC
- (b) Facility Rating 2200 A
- (c) Point of Origin Hassayampa switchyard
- (d) Intermediate Points of Interconnection
- (e) Point of Termination North Gila substation; Sec. 11, T8S, R22W
- (f) Length Approximately 110 miles

**Routing** This line will generally follow the route of the existing Hassayampa-Hoodoo Wash-North Gila 500kV #1 line.

**Purpose** This project will increase the import capability for the Yuma area and export/scheduling capability from the Palo Verde area to provide access to both solar and gas resources. This project will also allow the system to accommodate generation interconnection requests.

**Date**

- (a) Construction Start 2013 (In progress)
- (b) Estimated In-Service Spring 2015

**Permitting / Siting Status** CEC issued 1/23/08 (Case No. 135, Decision No. 70127, Palo Verde Hub to North Gila 500kV Transmission Line project). An amendment to the original CEC was granted on 12/3/13, Decision No. 74206, to relocate a 1,500 foot segment of the approved corridor east of the North Gila substation. Construction activities began in mid-2013. Note – the Hassayampa line was previously referred to as Palo Verde Hub to North Gila.

**Arizona Public Service Company  
2015 – 2024  
Ten-Year Plan  
Planned Transmission Description**

**2015**

<u>Project Name</u>	Palm Valley – TS2 – Trilby Wash 230kV Line
<u>Project Sponsor</u>	Arizona Public Service Company
<u>Other Participants</u>	None
<u>Size</u>	
(a) Voltage Class	230kV AC
(b) Facility Rating	3000 A
(c) Point of Origin	Palm Valley substation; Sec. 24, T2N, R2W
(d) Intermediate Points of Interconnection	TS2 substation to be in-service by TBD; Sec. 25, T3N, R2W
(e) Point of Termination	Trilby Wash substation to be in-service in 2015; Sec. 20, T4N, R2W
(f) Length	Approximately 12 miles
<u>Routing</u>	North from the Palm Valley substation, generally following the Loop 303 to Cactus Road, west on Cactus Road to approximately 191st Avenue, and then north on 191st Avenue to the Trilby Wash substation.
<u>Purpose</u>	This project will serve the need for electric energy in the western Phoenix Metropolitan area and additional import capability into the greater Phoenix Metro area. The Trilby Wash substation will be a new transmission source for the far northwestern part of the valley, which will provide improved system reliability for communities in the area; such as El Mirage, Surprise, Youngtown, Goodyear, and Buckeye. The first circuit is scheduled to be in-service for the summer of 2015; the in-service date for the second circuit will be evaluated in future planning studies.
<u>Date</u>	
(a) Construction Start	2014 (In progress)
(b) Estimated In-Service	Summer 2015
<u>Permitting / Siting Status</u>	<i>The Palm Valley-TS2 segment of the 230kV line was sited in the West Valley South 230kV Transmission Line project and a CEC was issued 12/22/03 (Case No. 122, Decision No. 66646). An amendment to the CEC terms was granted on 6/27/2013 (Decision No. 73937) for the first circuit of the Project to 12/23/2018 and for the second circuit and other facilities to 12/23/2028. The Trilby Wash-TS2 segment of the 230kV line was sited in the West Valley North 230kV Transmission Line project and a CEC was issued 5/5/2005 (Case No. 127, Decision No. 67828). On November 3, 2014 APS filed an application to amend CEC requesting term extensions of the first circuit to May 5, 2020 and for the second circuit to May 5, 2030 and other minor modifications to the CEC.</i>

**Arizona Public Service Company  
2015 – 2024  
Ten-Year Plan  
Planned Transmission Description**

**2015**

<b><u>Project Name</u></b>	Bagdad 115kV Relocation Project
<b><u>Project Sponsor</u></b>	Arizona Public Service Company
<b><u>Other Participants</u></b>	None
<b><u>Size</u></b>	
(a) Voltage Class	115kV AC
(b) Facility Rating	700 A
(c) Point of Origin	Bagdad Capacitor switchyard; Sec. 10, T14N, R9W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Bagdad Mine substation; Sec. 31, T15N, R9W
(f) Length	Approximately 5.5 miles
<b><u>Routing</u></b>	Beginning at the existing APS capacitor switchyard and extending in a southwesterly direction for approximately 1.5 miles, then turning in a northwesterly direction approximately 4 miles to the existing Bagdad Mine substation. The project primarily crosses federal BLM lands, private lands (owned by the mine) and a short segment on Arizona State Trust Lands.
<b><u>Purpose</u></b>	Freeport McMoRan Inc. ("FMI") has plans to expand the mine in the location of the existing 115kV transmission line. FMI requested that APS move the line in a southerly direction beyond the limits of the planned expansion.
<b><u>Date</u></b>	
(a) Construction Start	2014
(b) Estimated In-Service	2015
<b><u>Permitting / Siting Status</u></b>	<i>CEC issued on 7/16/09 (Case No. 143, Decision No. 71217, Bagdad 115kV Relocation Project). An amendment to the original CEC was granted on 11/21/12, Decision No. 73586, expanding a portion of the project corridor on FMI property to accommodate rerouting this line.</i>



**Arizona Public Service Company  
2015 – 2024  
Ten-Year Plan  
Planned Transmission Description**

**2016**

<b><u>Project Name</u></b>	Delaney – Palo Verde 500kV Line
<b><u>Project Sponsor</u></b>	Arizona Public Service Company
<b><u>Other Participants</u></b>	Central Arizona Water Conservation District (CAWCD)
<b><u>Size</u></b>	
(a) Voltage Class	500kV AC
(b) Facility Rating	3000 A
(c) Point of Origin	Palo Verde Switchyard
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Delaney Switchyard; Sec. 25, T2N, R8W
(f) Length	Approximately 15 miles
<b><u>Routing</u></b>	Generally leaving the Palo Verde Hub vicinity following the Palo Verde-Colorado River-Devers #1 and the Hassayampa-Harquahala 500kV lines to the Delaney Switchyard site in Sec. 25, T2N, R8W.
<b><u>Purpose</u></b>	This project is anticipated to interconnect generation projects at the Delaney switchyard. This line is also one section of a new 500kV path from Palo Verde around the western and northern edges of the Phoenix area and terminating at Pinnacle Peak. This is a joint participation project. APS will serve as the project manager.
<b><u>Date</u></b>	
(a) Construction Start	2011
(b) Estimated In-Service	2016
<b><u>Permitting / Siting Status</u></b>	<i>CEC issued 8/17/05 (Case No. 128, Decision No. 68063, Palo Verde Hub to TS5 500kV Transmission project). APS, as project manager, holds the CEC. On November 13, 2014 APS filed an application to extend the term of the CEC for the portion of line from the Delaney Switchyard to the Sun Valley Substation from August 17, 2015 to August 17, 2020. In that filing APS also requested other minor modifications to the CEC.</i>

**Arizona Public Service Company  
2015 – 2024  
Ten-Year Plan  
Planned Transmission Description**

**2016**

<b><u>Project Name</u></b>	Delaney – Sun Valley 500kV Line
<b><u>Project Sponsor</u></b>	Arizona Public Service Company
<b><u>Other Participants</u></b>	Central Arizona Water Conservation District (CAWCD)
<b><u>Size</u></b>	
(a) Voltage Class	500kV AC
(b) Facility Rating	3000 A
(c) Point of Origin	Delaney Switchyard; Sec. 25, T2N, R8W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Sun Valley substation to be in-service by 2016; Sec. 29, T4N, R4W
(f) Length	Approximately 28 miles
<b><u>Routing</u></b>	Generally follows the Palo Verde-Colorado River-Devers #1 line until crossing the CAP canal. Then easterly, generally following the north side of the CAP canal to the new Sun Valley substation.
<b><u>Purpose</u></b>	This project will increase the import capability to the Phoenix Metropolitan area as well as increase the export/scheduling capability from the Palo Verde area to provide access to both solar and gas resources. It will also serve projected need for electric energy in the area immediately north and west of the Phoenix Metropolitan area. The project will increase the system reliability by providing a new transmission source to help serve the areas in the western portions of the Phoenix Metropolitan area. This is a joint participation project with APS as the project manager.
<b><u>Date</u></b>	
(a) Construction Start	2014
(b) Estimated In-Service	2016
<b><u>Permitting / Siting Status</u></b>	<i>CEC issued 8/17/05 (Case No. 128, Decision No. 68063, Palo Verde Hub to TS5 500kV Transmission project). APS, as project manager, holds the CEC. On November 13, 2014 APS filed an application to extend the term of the CEC for the segment of line from the Delaney Switchyard to the Sun Valley Substation to August 17, 2020. In that filing APS also requested other minor modifications to the CEC.</i>



**Arizona Public Service Company  
2015 – 2024  
Ten-Year Plan  
Planned Transmission Description**

**2016**

<u>Project Name</u>	Sun Valley – Trilby Wash 230kV Line
<u>Project Sponsor</u>	Arizona Public Service Company
<u>Other Participants</u>	None
<u>Size</u>	
(a) Voltage Class	230kV AC
(b) Facility Rating	3000 A
(c) Point of Origin	Sun Valley substation to be in-service by 2016; Sec. 29, T4N, R4W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Trilby Wash substation to be in-service in 2015; Sec. 20, T4N, R2W
(f) Length	Approximately 15 miles
<u>Routing</u>	East from the Sun Valley substation along the CAP canal to approximately 243rd Ave., south to the existing 500kV transmission line corridor, and then east along the corridor to the Trilby Wash substation.
<u>Purpose</u>	This project is required to serve the need for electric energy in the western Phoenix Metropolitan area. Also, the project will provide more capability to import power into the Phoenix Metropolitan area along with improved reliability for communities in the area. The first circuit is scheduled to be in-service for the summer of 2016 and the in-service date for the second circuit will be evaluated in future planning studies.
<u>Date</u>	
(a) Construction Start	2014
(b) Estimated In-Service	2016
<u>Permitting / Siting Status</u>	CEC issued 5/5/05 (Case No. 127, Decision No. 67828, West Valley North 230kV Transmission Line project). On November 3, 2014 APS filed an application to extend the term of the CEC to May 5, 2020 for the first circuit and to May 5, 2030 for the second circuit and other minor modifications to the CEC.

**Arizona Public Service Company  
2015 – 2024  
Ten-Year Plan  
Planned Transmission Description**

**2017**

<u>Project Name</u>	Mazatzal 345/69kV Substation
<u>Project Sponsor</u>	Arizona Public Service Company
<u>Other Participants</u>	None
<u>Size</u>	
(a) Voltage Class	345kV AC
(b) Facility Rating	150 MVA
(c) Point of Origin	Cholla-Pinnacle Peak 345kV line; near Sec. 3, T8N, R10E
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Mazatzal substation to be in-service by 2017; Sec. 3, T8N, R10E
(f) Length	Less than 1 mile
<u>Routing</u>	The Mazatzal 345/69kV substation will be constructed adjacent to the Cholla-Pinnacle Peak 345kV line corridor.
<u>Purpose</u>	This project is needed to provide the electric source and support to the sub-transmission system in the area of Payson and the surrounding communities. Additionally, improved reliability will result for the communities in the Payson area.
<u>Date</u>	
(a) Construction Start	2015
(b) Estimated In-Service	2017
<u>Permitting / Siting Status</u>	<i>CEC issued on 5/4/11 (Case No. 160, Decision No. 72302, Mazatzal Substation and 345kV Interconnection Project).</i>

**Arizona Public Service Company  
2015 – 2024  
Ten-Year Plan  
Planned Transmission Description**

**2017**

<u>Project Name</u>	Ocotillo Modernization Project
<u>Project Sponsor</u>	Arizona Public Service Company
<u>Other Participants</u>	None
<u>Size</u>	
(a) Voltage Class	230kV AC
(b) Facility Rating	To be determined
(c) Point of Origin	Ocotillo GT3-7 Collection Yard
(d) Intermediate Points of Interconnection	None
(e) Point of Termination	Ocotillo 230kV Substation
(f) Length	Less than 1 mile
<u>Routing</u>	This project will include two onsite 230kV generation interconnection circuits for interconnection to the existing onsite Ocotillo 230kV Substation. One circuit will be routed along a portion of the northern boundary of the site, connecting from immediately north of GT7 to the substation. The second circuit will be routed along portions of the western and northern boundaries of the site, connecting immediately south of GT3 to the substation. In addition, the existing generation interconnection from existing GT2 will be rerouted, such that it will connect near GT7.
<u>Purpose</u>	APS has plans to modernize the Ocotillo Power Plant by retiring two 1960's-era steam generators and replacing them with five (5) quick-start natural Gas Turbines (GTs), and constructing associated 230kV transmission generation interconnection circuits. These circuits will connect the new units to the existing Ocotillo 230kV Substation.
<u>Date</u>	
(a) Construction Start	2016
(b) Estimated In-Service	2017-2018
<u>Permitting / Siting Status</u>	CEC issued on 11/13/2014. (Case No. 169, Decision No. 74812, Ocotillo Modernization Project). Note – Ocotillo 230kV Generation Interconnections is now referred to as Ocotillo Modernization Project.

**Arizona Public Service Company  
2015 – 2024  
Ten-Year Plan  
Planned Transmission Description**

**2018**

<u>Project Name</u>	North Gila – Orchard 230kV Line
<u>Project Sponsor</u>	Arizona Public Service Company
<u>Other Participants</u>	None
<u>Size</u>	
(a) Voltage Class	230kV AC
(b) Facility Rating	3000 A
(c) Point of Origin	North Gila substation; Sec. 11, T8S, R22W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Orchard 230kV substation to be in-service by 2018; Sec. 20, T9S, R22W
(f) Length	Approximately 13 miles
<u>Routing</u>	In general the line will proceed south from the North Gila substation until County 6 ½ Street, where it will head east for approximately 1 mile. Then following the existing Western Area Power Administration utility right-of-way south to County 9 ½ Street, where it will proceed east for approximately 0.3 mile before heading south on Avenue 10E. Then the route will proceed southwest adjacent to the Union Pacific Railroad and then adjacent to the A Canal until it turns south along the Yuma Area Service Highway alignment. The route then proceeds west along the County 13 ½ Street alignment to Avenue 5 ½E, where it will turn south to the Orchard Substation.
<u>Purpose</u>	This project serves the need for electric energy, improved reliability, and continuity of service for the greater Yuma area. This project will be built to be double-circuit capable with one circuit in-service in 2018 and the second circuit in-service at a date to be determined.
<u>Date</u>	
(a) Construction Start	2016
(b) Estimated In-Service	2018
<u>Permitting / Siting Status</u>	CEC issued 2/2/12 (Case No. 163, Decision No. 72801, North Gila to TS8 to Yucca 230kV Transmission Line project). Note – TS8 to Yucca 230KV Transmission Line is now referred to as North Gila – Orchard 230kV Line.

**Arizona Public Service Company  
2015 – 2024  
Ten-Year Plan  
Planned Transmission Description**

**2018**

<u>Project Name</u>	Morgan – Sun Valley 500kV Line
<u>Project Sponsor</u>	Arizona Public Service Company
<u>Other Participants</u>	Central Arizona Water Conservation District (CAWCD)
<u>Size</u>	
(a) Voltage Class	500kV AC
(b) Facility Rating	3000 A
(c) Point of Origin	Sun Valley substation to be in-service in 2016; Sec. 29, T4N, R4W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Morgan substation; Sec. 33, T6N, R1E
(f) Length	Approximately 38 miles
<u>Routing</u>	Generally the line will head north-northeast out of the Sun Valley substation and then east to the Morgan substation.
<u>Purpose</u>	This project will serve the electric energy needs in the northern Phoenix Metropolitan area. The project will also increase the reliability of the EHV system by completing a 500kV loop that connects the Palo Verde Transmission system, the Southern Navajo Transmission system, and the Southern Four Corners system. Additionally, the project will increase reliability by providing a second 500kV source for the Sun Valley substation and providing support for multiple Category C and D transmission contingencies. It will also increase the import capability to the Phoenix Metropolitan area, as well as increase the export/scheduling capability from the Palo Verde Hub area, which includes both solar and gas resources. This project is 500/230kV double-circuit capable.
<u>Date</u>	
(a) Construction Start	2015
(b) Estimated In-Service	2018
<u>Permitting / Siting Status</u>	CEC issued on 3/17/09 (Case No. 138, Decision No. 70850, TS5-TS9 500/230kV Project). An amendment request was filed on 7/17/2014 with the ACC to extend the term of the 500kV circuit to 2021 and to make other modifications to the CEC.

**Arizona Public Service Company  
2015 – 2024  
Ten-Year Plan  
Planned Transmission Description**

**2026**

<b><u>Project Name</u></b>	Morgan – Sun Valley 230kV Line
<b><u>Project Sponsor</u></b>	Arizona Public Service Company
<b><u>Other Participants</u></b>	None
<b><u>Size</u></b>	
(a) Voltage Class	230kV AC
(b) Facility Rating	To be determined
(c) Point of Origin	Sun Valley substation to be in-service by 2016; Sec. 29, T4N, R4W
(d) Intermediate Points of Interconnection	To be determined
(e) Point of Termination	Morgan substation; Sec. 33, T6N, R1E
(f) Length	Approximately 38 miles
<b><u>Routing</u></b>	This line will be co-located with the Morgan-Sun Valley 500kV line, which generally heads north-northeast out of the Sun Valley substation and then east to the Morgan substation.
<b><u>Purpose</u></b>	This project is needed to provide a transmission source to serve future load that emerges in the currently undeveloped areas south and west of Lake Pleasant.
<b><u>Date</u></b>	
(a) Construction Start	2025
(b) Estimated In-Service	2026
<b><u>Permitting / Siting Status</u></b>	<i>CEC issued on 3/17/09 (Case No. 138, Decision No. 70850, TS5-TS9 500/230kV Project). An amendment request was filed on 7/17/2014 with the ACC to extend the term of the 230kV circuit to 2030 and to make other modifications to the CEC.</i>

**Arizona Public Service Company  
2015 – 2024  
Ten-Year Plan  
Planned Transmission Description**

**To Be Determined**

Project Name Scatter Wash 230/69kV Substation

Project Sponsor Arizona Public Service Company

Other Participants None

Size

- (a) Voltage Class 230kV AC
- (b) Facility Rating 188 MVA
- (c) Point of Origin Pinnacle Peak-Raceway 230kV line; Sec. 8, T4N, R3E
- (d) Intermediate Points of Interconnection
- (e) Point of Termination Scatter Wash substation; Sec. 8, T4N, R3E
- (f) Length Less than 1 mile

Routing The Scatter Wash substation will be located adjacent to the Pinnacle Peak-Raceway 230kV line.

Purpose This project is needed to provide electric energy in the northern portions of the Phoenix Metropolitan area as well as increase the reliability for these areas.

Date

- (a) Construction Start To be determined
- (b) Estimated In-Service To be determined

Permitting / Siting Status

*CEC issued on 6/18/03 (Case No. 120, Decision No. 65997, North Valley Project. The Scatter Wash Substation was referred to as TS6 in Case 120). On April 10, 2013, Decision No. 73824, the Commission approved APS's application to extend the term by 10 years to June 18, 2023 and to relocate the Scatter Wash substation to the north side of the approved corridor.*

**Arizona Public Service Company  
2015 – 2024  
Ten-Year Plan  
Planned Transmission Description**

**To Be Determined**

<u>Project Name</u>	Avery 230/69kV Substation
<u>Project Sponsor</u>	Arizona Public Service Company
<u>Other Participants</u>	None
<u>Size</u>	
(a) Voltage Class	230kV AC
(b) Facility Rating	188 MVA
(c) Point of Origin	Pinnacle Peak-Raceway 230kV line; Sec. 8, T4N, R3E
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Avery substation; Sec. 15, T5N, R2E
(f) Length	Less than 1 mile
<u>Routing</u>	The Avery substation will be constructed adjacent to the Pinnacle Peak-Raceway 230kV line at approximately the Dove Valley Rd. and 39 <sup>th</sup> Ave. alignments.
<u>Purpose</u>	This project is needed to provide electric energy in the northern portions of the Phoenix Metropolitan area as well as increase the reliability for these areas. The need date for this substation is continuously evaluated as the load growth in the area is monitored.
<u>Date</u>	
(a) Construction Start	To be determined
(b) Estimated In-Service	To be determined
<u>Permitting / Siting Status</u>	<i>CEC issued on 6/18/03 (Case No. 120, Decision No. 65997, North Valley Project). On April 10, 2013, Decision No. 73824, the Commission approved APS's application to extend the term by 10 years to June 18, 2023 and make other minor modifications unrelated to this substation.</i>



**Arizona Public Service Company  
2015 – 2024  
Ten-Year Plan  
Planned Transmission Description**

**To Be Determined**

<u>Project Name</u>	Pinal Central – Sundance 230kV Line
<u>Project Sponsor</u>	Arizona Public Service Company
<u>Other Participants</u>	ED-2
<u>Size</u>	
(a) Voltage Class	230kV AC
(b) Facility Rating	3000 A
(c) Point of Origin	Sundance substation; Sec. 2, T6S, R7E
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Pinal Central substation to be in-service by 2014; Sec. 30, T6S, R8E
(f) Length	Approximately 6 miles
<u>Routing</u>	The project will originate at a new substation on the Sundance property, proceeding west and then south along Curry Road to the half-section between State Route 287 and Earley Road. The final west to east alignment connecting into the Pinal Central Substation will be located within an ACC-approved corridor and is subject to further design and right-of-way acquisition analysis.
<u>Purpose</u>	This project will serve increasing loads in Pinal County and throughout the APS system, and will improve reliability and continuity of service for the communities in the area. Also, the project will increase the reliability of Sundance by providing a transmission line in a separate corridor than the existing lines that exit the plant. The project will be constructed as a 230kV double-circuit capable line, but initially operated as a single-circuit. The in-service date for the second circuit will be evaluated in future planning studies.
<u>Date</u>	
(a) Construction Start	To be determined
(b) Estimated In-Service	To be determined
<u>Permitting / Siting Status</u>	<i>CEC issued 4/29/08 (Case No. 136, Decision No. 70325, Sundance to Pinal South 230kV Transmission Line project). Note – the Pinal South substation is now referred to as Pinal Central. The Sundance – Faul 230 kV Line (construction was limited to inside the Sundance Property) was placed into service in May 2010 as a portion of this project.</i>

**Arizona Public Service Company  
2015 – 2024  
Ten-Year Plan  
Planned Transmission Description**

**To Be Determined**

<u>Project Name</u>	Komatke 230/69kV Substation
<u>Project Sponsor</u>	Arizona Public Service Company
<u>Other Participants</u>	None
<u>Size</u>	
(a) Voltage Class	230kV AC
(b) Facility Rating	188 MVA
(c) Point of Origin	Liberty (TS4)-Panda 230kV line; Sec. 25, T2S, R4W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Komatke 230/69 substation with an in-service TBD; Sec. 25, T2S, R4W
(f) Length	Less than 1 mile
<u>Routing</u>	The Komatke 230/69kV substation will be constructed adjacent to the Liberty (TS4)-Panda 230kV line.
<u>Purpose</u>	This project will provide the electrical source and support to the sub-transmission system to serve the need for electric energy for the communities including Buckeye, Goodyear, and Gila Bend. The project will also increase the reliability for those areas.
<u>Date</u>	
(a) Construction Start	To be determined
(b) Estimated In-Service	To be determined
<u>Permitting / Siting Status</u>	<i>CEC issued 10/16/00 (Case No. 102, Decision No. 62960, Gila River Transmission Project) for the Gila River Transmission Project which included the interconnection of the 230kV substation. Note – Jojoba 230/69kV Substation is now referred to as Komatke 230/69kV Substation.</i>

**Arizona Public Service Company  
2015 – 2024  
Ten-Year Plan  
Planned Transmission Description**

**To Be Determined**

<u>Project Name</u>	Orchard – Yucca 230kV Line
<u>Project Sponsor</u>	Arizona Public Service Company
<u>Other Participants</u>	None
<u>Size</u>	
(a) Voltage Class	230kV AC
(b) Facility Rating	To be determined
(c) Point of Origin	Yucca substation; Sec. 36, T7S, R24W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Orchard 230kV substation to be in-service by 2018; Sec. 20, T9S, R22W
(f) Length	Approximately 19 miles
<u>Routing</u>	The line will proceed west from the Orchard substation along County 14 <sup>th</sup> Street to the A Canal. Then the route will proceed southwest along the A Canal to Avenue 4E, where it will continue west along County 14 ½ Street to US 95. The line will proceed north along US 95 to the County 13 ½ Street alignment and proceed west along County 13 ½ and County 13 <sup>th</sup> Street. At Avenue F the line will proceed north to Levee Road, where it will proceed north east until the 8 <sup>th</sup> Street alignment. The line will proceed east along 8 <sup>th</sup> Street until Calle Agua Salada Road, where it will proceed north to the Yucca Power Plant.
<u>Purpose</u>	This double-circuit 230kV project will serve the need for electric energy, improve reliability, and continuity of service for the greater Yuma area. Additionally, this project will provide a second electrical source to the future Orchard substation. The ability to transmit electric energy generated by renewable resources in the region may be an additional benefit subject to study by APS in regional planning forums.
<u>Date</u>	
(a) Construction Start	To be determined
(b) Estimated In-Service	To be determined
<u>Permitting / Siting Status</u>	CEC issued 2/2/12 (Case No. 163, Decision No. 72801, North Gila to TS8 to Yucca 230kV Transmission Line project). Note – TS8 to Yucca 230 kV Line is now referred to as Orchard – Yucca 230 KV Line.

**Arizona Public Service Company  
2015 – 2024  
Ten-Year Plan  
Planned Transmission Description**

**To Be Determined**

Project Name Sun Valley – TS10 –TS11 230kV Line

Project Sponsor Arizona Public Service Company

Other Participants None

Size

- (a) Voltage Class 230kV AC
- (b) Facility Rating To be determined
- (c) Point of Origin Sun Valley substation to be in-service by 2016; Sec. 29, T4N, R4W
- (d) Intermediate Points of Interconnection A future TS10 substation; location to be determined
- (e) Point of Termination A future TS11 substation; location to be determined
- (f) Length To be determined

Routing The routing for this line has not yet been determined.

Purpose This project is needed to provide a transmission source to serve future load that emerges in the currently undeveloped areas northwest of the White Tank Mountains. This line is anticipated to be a 230kV line originating from the Sun Valley substation, with the future TS10 230/69kV substation to be interconnected into the 230kV line.

Date

- (a) Construction Start To be determined
- (b) Estimated In-Service To be determined

Permitting / Siting Status *An application for a CEC has not yet been filed.*

**Arizona Public Service Company  
2015 – 2024  
Ten-Year Plan  
Planned Transmission Description**

**To Be Determined**

<u>Project Name</u>	Buckeye – TS11 – Sun Valley 230kV Line
<u>Project Sponsor</u>	Arizona Public Service Company
<u>Other Participants</u>	None
<u>Size</u>	
(a) Voltage Class	230kV AC
(b) Facility Rating	To be determined
(c) Point of Origin	Sun Valley substation to be in-service by 2016; Sec. 29, T4N, R4W
(d) Intermediate Points of Interconnection	A future TS11 substation; location to be determined
(e) Point of Termination	Buckeye substation; Sec. 7, T1N, R3W
(f) Length	To be determined
<u>Routing</u>	The routing for this line has not yet been determined.
<u>Purpose</u>	This project will serve the need for electric energy in the largely undeveloped areas west of the White Tank Mountains. This project will provide the first portion of the transmission infrastructure in this largely undeveloped area and will provide a transmission connection between the northern and southern transmission sources that will serve the area. Improved reliability will result for this portion of Maricopa County. It is anticipated that this project will be constructed with double-circuit capability, but initially operated as a single-circuit. The in-service date and location of the TS11 230/69kV substation will be determined in future planning studies based upon the development of the area.
<u>Date</u>	
(a) Construction Start	To be determined
(b) Estimated In-Service	To be determined
<u>Permitting / Siting Status</u>	<i>An application for a CEC has not yet been filed.</i>

**Arizona Public Service Company  
2015 – 2024  
Ten-Year Plan  
Planned Transmission Description**

**To Be Determined**

<u>Project Name</u>	El Sol – Westwing 230kV Line
<u>Project Sponsor</u>	Arizona Public Service Company
<u>Other Participants</u>	None
<u>Size</u>	
(a) Voltage Class	230kV AC
(b) Facility Rating	To be determined
(c) Point of Origin	Westwing substation; Sec. 12, T4N, R1W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	El Sol substation; Sec. 30, T3N, R1E
(f) Length	Approximately 11 miles
<u>Routing</u>	Generally following the existing Westwing-Surprise-El Sol 230kV corridor.
<u>Purpose</u>	This project will increase system capacity to serve the Phoenix Metropolitan area, while maintaining system reliability and integrity for delivery of bulk power from Westwing south into the APS Phoenix Metropolitan area 230kV transmission system.
<u>Date</u>	
(a) Construction Start	To be determined
(b) Estimated In-Service	To be determined
<u>Permitting / Siting Status</u>	<i>CEC issued 7/26/73 (Case No. 9, Docket No. U-1345). Note that this Certificate authorizes two double-circuit lines. Construction of the first double-circuit line was completed in March 1975. Construction of the second line, planned to be built with double- circuit capability, but initially operated with a single-circuit, is described above.</i>

**Arizona Public Service Company  
2014 – 2023  
Ten-Year Plan  
Planned Transmission Description**

**To Be Determined**

<u>Project Name</u>	Palo Verde – Saguaro 500kV Line
<u>Project Sponsor</u>	Arizona Public Service Company
<u>Other Participants</u>	To be determined

Size

- |  |  |
|--|--|
| (a) Voltage Class                          | 500kV AC                                 |
| (b) Facility Rating                        | To be determined                         |
| (c) Point of Origin                        | Palo Verde switchyard; Sec. 34, T1N, R6W |
| (d) Intermediate Points of Interconnection |  |
| (e) Point of Termination                   | Saguaro substation; Sec. 14, T10S, R10E  |
| (f) Length                                 | Approximately 130 miles                  |

Routing

Generally south and east from the Palo Verde area to a point near Gillespie Dam, then generally easterly until the point at which the Palo Verde-Kyrene 500kV line diverges to the north and east. The corridor then continues generally south and east again, adjacent to a gas line corridor, until converging with the Tucson Electric Power Company's Westwing-Pinal West-South 345kV line. The corridor follows the 345kV line until a point due west of the Saguaro Generating Station. The corridor then follows a lower voltage line into the 500kV yard just south and east of the Saguaro Generating Station.

Purpose

The line will increase the adequacy of the existing EHV transmission system and increase power delivery throughout the state.

Date

- |                          |                  |
|--------------------------|------------------|
| (a) Construction Start   | To be determined |
| (b) Estimated In-Service | To be determined |

<u>Permitting / Siting Status</u>	<i>CEC issued 1/23/76 (Case No. 24, Decision No. 46802).</i>
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*A subsidiary of Pinnacle West Capital Corporation*

# **TRANSMISSION PLANNING PROCESS AND GUIDELINES**

**APS Transmission Planning  
December 22, 2014**

**Ver 1.0**



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## **I. INTRODUCTION AND PURPOSE**

The Transmission Planning Process and Guidelines (Guidelines) are used by Arizona Public Service Company (APS) to assist in planning its Extra High Voltage (EHV) transmission system (345 kV and 500 kV) and High Voltage transmission system (230 kV and 115 kV). In addition to these Guidelines, APS follows the Western Electricity Coordinating Council's (WECC) System Performance Criteria (TPL-001-WECC-CRT-02) in addition to NERC Table 1.

## **II. PLANNING METHODOLOGY**

### **A. General**

APS uses a deterministic approach for transmission system planning. Under this approach, system performance should meet certain specific criteria under normal conditions (all lines in-service), for any single contingency condition and for selected double contingency conditions as defined under TPL-001-WECC-CRT-02. In general, an adequately planned transmission system will:

- Provide an acceptable level of service that is cost-effective for normal, single and selected double contingency conditions.
- Maintain service to all firm loads for any single or selected double contingency outages; except for radial loads.
- Not result in overloaded equipment or unacceptable voltage conditions for single or selected double contingency outages.
- Not result in cascading for single or selected double contingency outages.
- Provide for the proper balance between the transmission import capability and local generation requirements for an import limited load area.

Although APS uses a deterministic approach for transmission system planning, the WECC reliability planning criteria provides for exceptions based on methodologies provided by the WECC RPEWG. Historical system reliability performance is analyzed on a periodic basis and the results are used in the design of planned facilities.

These planning methodologies, assumptions, and guidelines are used as the basis for the development of future transmission facilities. Additionally,

consideration of potential alternatives to transmission facilities (such as distributed generation or new technologies) is evaluated on a case-specific basis.

As new planning tools and/or information become available revisions or additions to these guidelines will be made as appropriate.

## **B. Transmission Planning Process**

APS' transmission planning process consists of an assessment of the following needs:

- Provide adequate transmission to access designated network resources in-order to reliably and economically serve all network loads.
- Support APS' and other network customers' local transmission and sub-transmission systems.
- Provide for interconnection to new resources.
- Accommodate requests for long-term transmission access.

During this process, consideration is given to load growth patterns, other system changes affected by right-of-way, facilities siting constraints, routing of future transportation corridors, and joint planning with neighboring utilities, governmental entities, and other interested stakeholders (see APS OATT Attachment (E)). Finally, all EHV and HV substations will be CIP substations.

### **1. EHV Transmission Planning Process**

APS' EHV transmission system, which consists of 500 kV and 345 kV, has primarily been developed to provide transmission to bring the output of large base-loaded generators to load centers, such as Phoenix. Need for new EHV facilities may result from any of the bullet items described above. APS' annual planning process includes an assessment of APS' transmission capability to ensure that designated network resources can be accessed to reliably and economically serve all network loads. In addition, Reliability Must-Run (RMR) studies are selectively performed to ensure that proper balance between the transmission import capability and local generation requirements for an import limited load area are maintained.

## 2. 230 kV Transmission Planning Process

APS' 230 kV transmission system has primarily been developed to provide transmission to distribute power from the EHV bulk power substations and local generators to the distribution system and loads throughout the load areas.

Planning for the 230 kV system assesses the need for new 230/69 kV substations to support local sub-transmission and distribution system growth and the reliability performance of the existing 230 kV system. This process takes into account the future land use plans that were developed by government agencies, Landis aerial photo maps, master plans that were provided by private developers, and APS' long-range forecasted load densities per square mile for residential, commercial, and industrial loads.

## 3. Transmission Facilities Required for Generation/Resource Additions

New transmission facilities may also be required in conjunction with generation resources due to (1) a "merchant" request by an Independent Power Producer (IPP) for generator interconnection to the APS system, (2) a "merchant" request for point-to-point transmission service from the generator (receipt point) to the designated delivery point, or (3) designation of new resources or re-designation of existing units to serve APS network load (including removal of an older units' native load designation). These studies/processes are performed pursuant to the APS Open Access Transmission Tariff (OATT).

## C. Ten Year Transmission System Plans

Each year APS uses the planning process described in section B to update the Ten Year Transmission System Plan. The APS Ten Year Transmission System Plan identifies all new transmission facilities, 115 kV and above, and all facility replacements/upgrades required over the next ten years to reliably and economically serve the load.

#### **D. Regional Coordinated Planning**

##### **1. Western Electricity Coordinating Council (WECC)**

APS is a member of the WECC. The focus of the WECC is promoting the reliability of the interconnected bulk electric system. The WECC provides the means for:

- Developing regional planning and operating criteria.
- Coordinating future plans.
- Establishing new or modifying existing WECC Path Ratings through procedures.
- Compiling regional data banks, including the BCCS, for use by the member systems and the WECC in conducting technical studies.
- Assessing and coordinating operating procedures and solutions to regional problems.
- Establishing an open forum with interested non-project participants to review the plan of service for a project.
- Through the WECC Transmission Expansion Policy Committee, performing economic transmission congestion analysis.

APS works with WECC to adhere to these planning practices.

##### **2. Technical Task Force and ad-hoc Work Groups**

Many joint participant projects in the Desert Southwest rely on technical study groups for evaluating issues associated with their respective projects. These evaluations often include studies to address various types of issues associated with transfer capability, interconnections, reliability and security. APS actively participates in many of these groups such as the Western Arizona Transmission System Task Force, Four Corners Technical Task Force and the Eastern Arizona Transmission System Task Force.

##### **3. Sub-Regional Planning Groups**

Southwest Area Transmission Planning (SWAT) and other sub-regional planning groups provide a forum for entities within a region, and any other interested parties, to determine and study the needs of the region as a whole. It

also provides a forum for specific projects to be exposed to potential partners and allows for joint studies and participation from interested parties.

#### 4. WestConnect

APS and the other WestConnect members executed the WestConnect Project Agreement for Subregional Transmission Planning in May of 2007. This agreement promotes coordination of regional transmission planning for the WestConnect planning area by formalizing a relationship among the WestConnect members and the WestConnect area sub-regional planning groups including SWAT. The agreement provides for resources and funding for the development of a ten year integrated regional transmission plan for the WestConnect planning area. The agreement also ensures that the WestConnect transmission planning process will be coordinated and integrated with other planning processes within the Western Interconnection and with the WECC planning process.

#### 5. Joint Studies

In many instances, transmission projects can serve the needs of several utilities and/or IPPs. To this end, joint study efforts may be undertaken. Such joint study efforts endeavor to develop a plan that will meet the needs and desires of all individual companies involved.

#### E. Generation Schedules

For planning purposes, economic dispatches of network resources are determined for APS' system peak load in the following manner:

- Determine base generation available and schedule these units at maximum output.
- Determine resources purchased from other utilities, IPPs, or power marketing agencies.
- Determine APS' spinning reserve requirements.
- Schedule intermediate generation (oil/gas steam units) such that the spinning reserve requirements, in section (c) above, are met.
- Determine the amount of peaking generation (combustion turbine units) required to supply the remaining system peak load.

Phoenix area network resources are dispatched based on economics and any existing import limitations. When possible, spinning reserve will be carried on higher cost Phoenix area network generating units.

Generation output schedules for interconnected utilities and IPPs are based upon consultation with the neighboring utilities and IPPs or as modeled in the latest data in WECC coordinated study cases.

F. Load Projections

APS substation load projections are based on the APS Corporate Load Forecast. Substation load projections for neighboring interconnected utilities or power agencies operating in the WECC area are based on the latest data in WECC coordinated study cases. Heavy summer loads are used for the Ten Year Transmission System Plans.

G. Alternative Evaluations

1. General

In evaluating several alternative plans, comparisons of power flows, transient stability tests, and fault levels are made first. After the alternatives are found that meet the system performance criteria in each of these three areas comparisons may be made of the losses, transfer capability, impact on system operations, and reliability of each of the plans. Finally, the costs of facility additions (capital cost items), costs of losses, and relative costs of transfer capabilities are determined. A brief discussion of each of these considerations follows.

2. Power Flow Analyses

Power flows of base case (all lines in-service) and single contingency conditions are tested and should conform to the system performance criteria set forth in Section IV of these Guidelines. Double or multiple contingencies are also examined in the context of common mode and common corridor outages. Normal system voltages, voltage deviations, and voltage extreme limitations are based upon operating experience resulting in acceptable voltage levels to the customer.



Power flow limits are based upon the thermal ratings and/or sag limitations of conductors or equipment, as applicable.

3. Transient Stability Studies

Stability guidelines are established to maintain system stability for single contingency, three-phase fault conditions. Double or multiple contingencies are also examined in the context of common mode and common corridor outages.

4. Short Circuit Studies

Three-phase and single-phase-to-ground fault studies are performed to ensure the adequacy of system protection equipment to clear and isolate faults.

5. Reactive Power Margin Analyses

Reactive Power Margin analyses are performed when steady-state analyses indicate possible insufficient voltage stability margins. V-Q curve analyses are used to determine post-transient voltage stability.

6. Losses Analyses

A comparison of individual element and overall transmission system losses are made for each alternative plan being studied. The losses computed in the power flow program consist of the  $I^2R$  losses of lines and transformers and the core losses in transformers, where represented.

7. Transfer Capability Studies

In evaluating the relative merits of one or more EHV transmission plans, non-simultaneous ratings are determined using methodologies consistent with WECC Path Rating Procedures as defined in the *WECC Project Coordination and Path Rating Processes* manual and NERC Standard MOD-029-1. In addition, simultaneous relationships are identified that can either be mitigated through use of nomograms, operating procedures or other methods.

8. Subsynchronous Resonance (SSR)

SSR phenomenon result from the use of series capacitors in the network where the tuned electrical network exchanges energy with a turbine generator at one or more of the natural frequencies of the mechanical system. SSR countermeasures are applied to prevent damage to machines as a result of transient current or sustained oscillations following a system disturbance. SSR

studies are not used directly in the planning process. SSR countermeasures are determined after the transmission plans are finalized.

#### **9. FACTS (Flexible AC Transmission System)**

FACTS devices are a recent application of Power Electronics to the transmission system. These devices make it possible to use circuit reactance, voltage magnitude and phase angle as control parameters to redistribute power flows and regulate bus voltages, thereby improving power system operation.

FACTS devices can provide series or shunt compensation. These devices can be used as a controllable voltage source in series or as a controllable current source in shunt mode to improve the power transmission system operations.

FACTS will be evaluated as a means of power flow control and/or to provide damping to dynamic oscillations where a need is identified and it is economically justified. Examples include DSTATCOM for powerfactor correction and the DVR for dynamic voltage regulation for distribution loads.

#### **10. Economic Evaluation**

In general, an economic evaluation of alternative plans consists of a cumulative net present worth or equivalent annual cost comparison of capital costs.

### **III. PLANNING ASSUMPTIONS**

#### **A. General**

##### **1. Loads**

Loads used for the APS system originate from the latest APS Corporate Load Forecast. In most cases, the corrected power factor of APS loads is 99.5% at 69 kV substations.

##### **2. Generation and Other Resources**

Generation dispatch is based on firm power and/or transmission wheeling contracts including network resources designations.

### 3. Normal Voltage Levels

Nominal EHV design voltages are 500 kV, 345 kV, 230 kV, and 115 kV. Nominal EHV operating voltages are 535 kV, 348 kV, 239 kV, and 119 kV, with exceptions to certain buses.

### 4. Sources of Databases

APS currently relies on WECC cases and internal data listings as their depository of EHV and HV system data and models. WECC has chosen to pursue a relational database (i.e. Base Case Coordination System) to maintain data and models for its members in addition to using WECC base cases. APS will begin to use the BCCS as the system becomes available.

### 5. Voltage Control Devices

Devices which can control voltages are shunt capacitors, shunt reactors, tap-changing-under-load (TCUL) and fixed-tap transformers, static Volt Ampere Reactive (VAR) compensators, and machine VAR capabilities. If future voltage control devices are necessary, these devices will be evaluated based upon economics and the equipment's ability to obtain an adequate voltage profile on the EHV and HV systems. Currently, APS has TCULs on only its 500 kV autotransformers except for a few transformers. Other than operator control, the TCUL transformers do not automatically regulate voltages.

### 6. Phase Shifters

For pre-disturbances scenarios, phase shifters may be used to hold flows depending on the objectives of the study. For post-disturbance scenarios, the phase shifters are assumed to not hold flows and are not automatically regulated.

### 7. Conductor Sizes

APS uses several types of standard phase conductors depending on the design, voltage class and application for new transmission lines. Table 1 lists the current standard conductor sizes for the various voltage levels used for new facilities.

Table 1. Standard conductor sizes.

Class	Conductor
525 kV	3x1780 kcm ACSR Chukar 2x2156 kcm ACSR Bluebird
345 kV	2x795 kcm ACSR Tern

230 kV	1x2156 kcm ACSS Bluebird 1x1272 kcm ACSR Bittern 1x795 kcm ACSR Tern
115 kV	(same as 230 kV construction)
69 kV	1x795 kcm ACSS Tern 1x795 kcm AA Arbutus 1x336 kcm ACSR Linnet

## 8. 69 kV System Modeling

230 kV facility outages may impact the underlying 69 kV system due to the interconnection of those systems. For this reason, power flow cases may include a detailed 69 kV system representation. Solutions to any problems encountered on the 69 kV system are coordinated with the subtransmission planning engineers.

## 9. Substation Transformers

- 500 kV and 345 kV Substations

Bulk substation transformer banks may be made up of one three-phase or three single-phase transformers, depending upon bank size and economics. For larger banks where single-phase transformers are used, a fourth (spare) single-phase transformer will be used in a jack-bus arrangement to improve reliability and facilitate connection of the spare in the event of an outage of one of the single-phase transformers.

TCULs are typically used on the 525 kV transformers generally with a range of plus or minus 10% of nominal voltage. Primary voltages will be 525 kV or 345 kV, and secondary voltages will be 230 kV or 69 kV and tertiary voltages will be 34.5 kV, 14.4 kV or 12.47 kV.

- 230 kV Substations

For high-density load areas, both 230/69 kV and 69/12.5 kV transformers can be utilized. 230/69kV transformers will be rated at 113/150/188 MVA with a 65°C temperature rise, unless otherwise specified. 69/12.5kV transformers will be rated at 25/33/41 MVA with a 65°C temperature rise, unless otherwise specified.

With all elements in service, a transformer may be loaded up to its top Forced Air (ONAF) rating without sustaining any loss of service life. For a

single contingency outage (loss of one transformer) the remaining new transformer or transformers may be loaded up to 25% above their top ONAF rating, unless heat test data indicate a different overload capability. The loss of service life sustained will depend on the transformer pre-loading and the outage duration. No-load tap setting adjustment capabilities on 230/69 kV transformers will be  $\pm 5\%$  from the nominal voltage setting (230/69 kV) at  $2\frac{1}{2}\%$  increments.

#### 10. Switchyard Arrangements

- 500 kV and 345 kV Substations

Existing 345 kV switchyard arrangements use breaker-and-one-half, main-and-transfer, or modified paired-element circuit breaker switching schemes. Because of the large amounts of power transferred via 500 kV switchyards and the necessity of having adequate reliability, all 500 kV circuit breaker arrangements are planned for an ultimate breaker-and-one-half scheme. If only three or four elements are initially required, the circuit breakers are connected in a ring bus arrangement, but physically positioned for a breaker-and-one-half scheme. The maximum desired number of elements to be connected in the ring bus arrangement is four. System elements such as generators, transformers, and lines will be arranged in breaker-and-one-half schemes such that a failure of a center breaker will not result in the loss of two lines routed in the same general direction and will minimize the impact of losing two elements.

- 230 kV Substations

Future 230/69 kV substations should be capable of serving up to 452 Megavolt-Amps (MVA) of load. 400 MVA has historically been the most common substation load level in the Phoenix Metropolitan area. Future, typical 230/69 kV substations should accommodate up to four 230 kV line terminations and up to three 230/69 kV transformer bays. Based upon costs, as well as reliability and operating flexibility considerations, a breaker-and-one-half layout should be utilized for all future 230/69 kV Metropolitan Phoenix Area substations, with provision for initial development to be a ring

bus. Any two 230/69 kV transformers are to be separated by two breakers, whenever feasible, so that a stuck breaker will not result in an outage of both transformers.

#### **11. Series Capacitor Application**

Series capacitors are planned according to the needs of their associated transmission projects and are typically a customized design. Benefits resulting from the installation of series capacitors include but are not limited to improved transient stability, voltage regulating capability and reactive capability. A new series capacitor installation will currently include MOV protection that mitigates fault current levels through the series capacitor for internal faults. A bank will typically bypass for internal faults because there is no benefit to requiring that the bank remain in service when the line is tripped. Depending on the required impedances and ampacity level, new series capacitor banks may be either one to three segment units. The bank ratings should be based upon line's ultimate uses. At a minimum bank should be upgradable to higher ampacity needs in the future. Most 500 kV banks in APS system have a continuous rating of either 1750 A or 2200 A. ANSI standard require that the 30 minutes emergency rating be 135% of the continuous.

#### **12. Shunt and Tertiary Reactor Application**

Shunt and/or tertiary reactors may be installed to prevent open end line voltages from being excessive, in addition to voltage control. The open end line voltage must not be more than 0.05 per unit voltage greater than the sending end voltage. Tertiary reactors may also be used for voltage and VAR control as discussed above. EHV reactors are used to adjust pre-disturbance voltages if controlled through a breaker, circuit switcher or motor operated disconnect switch. APS currently does not automatically control its EHV or HV reactors or capacitors.

### **B. Power Flow Studies**

#### **1. System Stressing**

Realistic generation capabilities and schedules should be used to stress the transmission system in order to maximize the transfer of resources during the maximum load condition or path rating studies. Existing WECC or regional path ratings and facilities ratings will not be violated pre- or facility ratings post-disturbance.

## 2. Displacement

In cases where displacements (due to power flow opposite normal generation schedules) may have an appreciable effect on transmission line loading, a reasonable amount of displacement (Generation Units) may be removed in-order to stress a given transmission path. Alternately, no fictitious generation sources may be used to stress paths.

## C. Transient Stability Studies

### 1. Fault Simulation

When studying system disturbances caused by faults, two conditions will be simulated:

- Three-phase-to-ground faults with normal clearing.
- Single-line-to-ground faults with a stuck circuit breaker in one phase with delayed clearing.

### 2. Margin

- Generation margin may be applied for the contingencies primarily affected by generation.
- Power flow margin may be applied for the contingencies primarily affected by power flow

### 3. Unit Tripping

Generator unit tripping may be allowed in-order to increase system stability performance if part of a proposed or existing remedial action scheme.

### 4. Machine Reactance Representation

For transient stability studies, the unsaturated transient reactance of machines with full representation will be used.

## 5. Fault Damping

Fault damping will be applied to the generating units adjacent to three phase faults. Fault damping levels will be determined from studies that account for the effect of generator amortisseur windings and the SSR filters. Fault damping will be applied on the buses listed in Table 2 for three phase faults on the nearest EHV or HV bus. If the model does not provide the ancillary signals for applying and removing damping values then a brake can be applied to the terminal bus of the affected generator.

Table 2. Damping levels for three phase faults.

Fault location	Affected units	Percent Damping
Palo Verde 500 kV	1-3	7.25%
Four Corners 500 & 345 kV	4&5	10%
Coronado 500 kV	1&2	12.5%
Cholla 500 kV	2-4	10%

## 6. Series Capacitor Switching

For APS designed banks, a MOV/by-pass model is employed in transient stability analysis.

## D. Short Circuit Studies

Three-phase and single-phase-to-ground faults will be evaluated.

### 1. Generation Representation

All generation will be represented.

### 2. Machine Reactance Representation

The saturated subtransient reactance ( $X''_d$ ) values will be used.

### 3. Line Representation

Unless previously calculated as part of APSs requirement for MOD-032, the transmission line zero sequence impedance ( $Z_0$ ) is assumed to be equal to three times the positive sequence impedance ( $Z_1$ ). If a new transmission impedance is required, APS utilizes the CAPE line constant program for determining sequence values.

### 4. Transformer Representation



The transformer zero sequence impedance ( $X_0$ ) is assumed to be equal to the positive sequence impedance ( $X_1$ ). Bulk substation transformers are modeled as auto-transformers. The two-winding model is that of a grounded-wye transformer. The three-winding model is that of a wye-delta-wye with a solid ground.

#### 5. Series Capacitor Switching

Series capacitors, locations to be determined from short circuit studies, will be flashed and reinserted as appropriate.

#### E. Reactive Power Margin Studies

Using Q-V curve analyses, APS assesses the interconnected transmission system to ensure there are sufficient reactive resources located throughout the electric system to maintain post-transient voltage stability for system normal conditions and certain contingencies.

### IV. SYSTEM PERFORMANCE

#### A. Power Flow Studies

##### 1. Normal (Base Case Conditions)

- Voltage Levels

- a. General

- i.

Nominal Voltage Level	Continuous Voltage Limits
525 kV	+/- 5%
345 kV	+/- 5%
230 kV	+/- 5%
115 kV	+/- 5%
69 kV	+/- 5%
Palo Verde	525-525 kV

- ii.

- Facility Loading Limits

- a. Transmission Lines

EHV transmission line loading cannot exceed 100% of the continuous rating, which is based upon established conductor temperature limit or sag limitation as defined by APS latest estimates for NERC Standard FAC-008-3.

b. Underground Cable

Underground cable loading should not exceed 100% of the continuous rating with all elements in service. This rating is based on a cable temperature of 85°C with no loss of cable life.

c. Transformers

For all transformers pre-disturbance flows cannot exceed APS established continuous ratings using methodologies used in reporting ratings under NERC Standard FAC-008-3.

d. Series Capacitors

Series Capacitors cannot exceed 100% of continuous rating as determined using methodologies used in reporting ratings under NERC Standard FAC-008-3.

- Interchange of VARS

Interchange of VARs between companies at interconnections will be reduced to a minimum and maintained near zero.

- Distribution of Flow

Schedules on a new project will be compared to simulated power flows to ensure a reasonable level of flowability.

2. Single and selected Double Contingency Outages

- Voltage Levels

Maximum voltage deviation on APS' major buses cannot exceed 5% for single contingencies and 10% for selected double contingencies. APS uses the following formulae to calculate voltage deviations for post-disturbance conditions.

$$\%Deviation = 100x\left(\frac{V_{pre} - V_{post}}{V_{pre}}\right)$$

- Facilities Loading Limits

a. Transmission Lines

Transmission line loading cannot exceed 100% of the lesser of the sag limit or the emergency rating (30-minute rating) which is based upon established conductor temperature limits.

b. Underground Cable

Underground cable loading should not exceed the emergency rating during a single-contingency outage. This rating is based on a cable temperature of 105°C for two hours of emergency operation with no loss of cable life.

c. Transformers

For all transformers post-disturbance flows cannot exceed APS established emergency ratings using methodologies used in reporting ratings under NERC Standard FAC-008-3.

d. Series Capacitors

Series Capacitors cannot exceed 100% of emergency rating as determined using methodologies used in reporting ratings under NERC Standard FAC-008-3.

- Generator Units

Generator units used for controlling remote voltages will be modified to hold their base case terminal voltages.

- Impact on Interconnected System

Single and selected double contingency outages will not cause overloads upon any neighboring transmission system.

**B. Transient Stability Studies**

Transient stability studies are primarily performed on the 500 kV and 345 kV systems but may be performed on lower voltage systems depending on the study objectives.

**1. Fault Simulation**

Three-phase and single-line-to-ground faults initiated disturbances will be simulated according to the guidelines described in NERC Table 1 as well as

WECC Regional Criteria TPL-001-WECC-CRT-2. Normal clearing times for different voltage levels are given Table 3 for new facilities. Fault damping will be applied when applicable at fault inception. Breaker failure operation on the 500 kV system has a minimum clearing time of 10 cycles.

Table 3. Normal clearing times for new facilities.

Voltage level	Normal clearing times
500 & 345 kV	4 cycle
230 kV	5 cycle
115 kV	5 cycle
≤69 kV	7 cycle

## 2. Series Capacitor Switching

All of APS's designed and installed series capacitor units are protected from internal faults using MOV and by-pass elements. For transient stability analysis, models are used to represent the mitigation provided by the MOV components or through by-passing of the series capacitors.

## 3. System Stability

The system performance will be considered acceptable if the following conditions are met:

- All machines in the system remain synchronized as demonstrated by the relative rotor angles.
- Positive system damping exists as demonstrated by the damping of relative rotor angles and the damping of voltage magnitude swings. For N-1 and N-2 disturbances, APS follows the voltage and frequency performance guidelines as described in NERC's Table 1 and WECC Regional Criteria TPL-001-WECC-CRT-2.
- Cascading does not occur for any category contingency.

## 4. Re-closing

Automatic re-closing of circuit breakers controlling EHV facilities is not utilized.

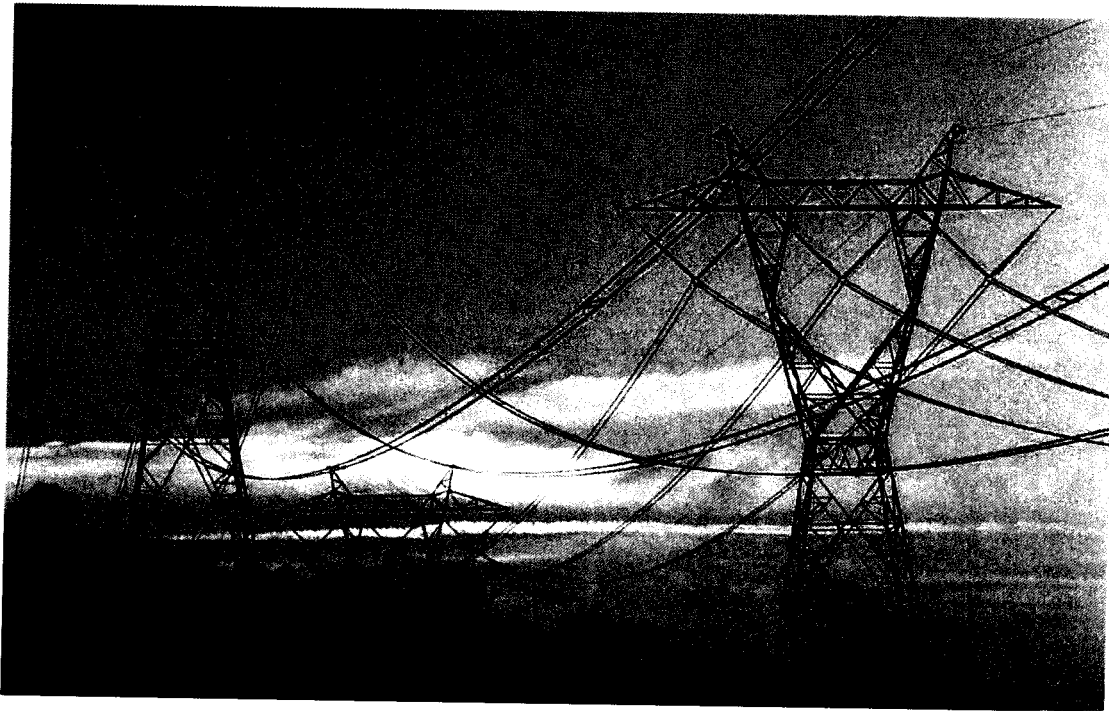
## 5. Short Circuit Studies

Fault current shall not exceed 100% of the applicable breaker fault current interruption capability for three-phase or single-line-to-ground faults.

**6. Reactive Power Margin Studies**

For system normal conditions or single contingency conditions, post-transient voltage stability is required with a path or load area modeled at a minimum of 105% of the path rating or maximum planned load limit for the area under study, whichever is applicable. For multiple contingencies, post-transient voltage stability is required with a path or load area modeled at a minimum of 102.5% of the path rating or maximum planned load limit for the area under study, whichever is applicable.

# **2014 SYSTEM RATING MAPS**



**PREPARED BY**

**Kawika Lawlor  
Joe Medina  
October 2014**

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LEGEND ----- 1



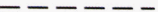

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METRO 230KV ----- 6

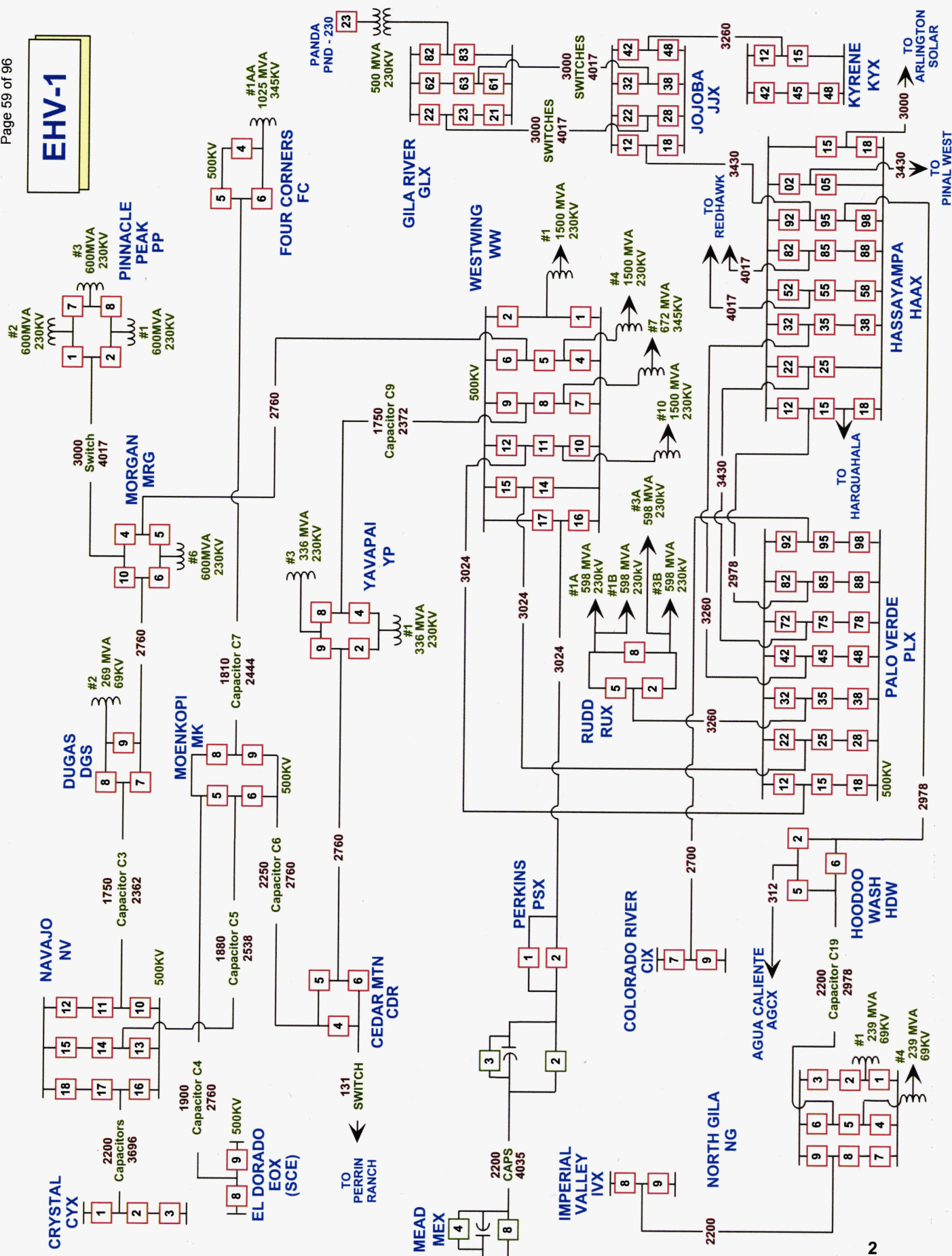
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SOUTHERN 230KV ----- 10

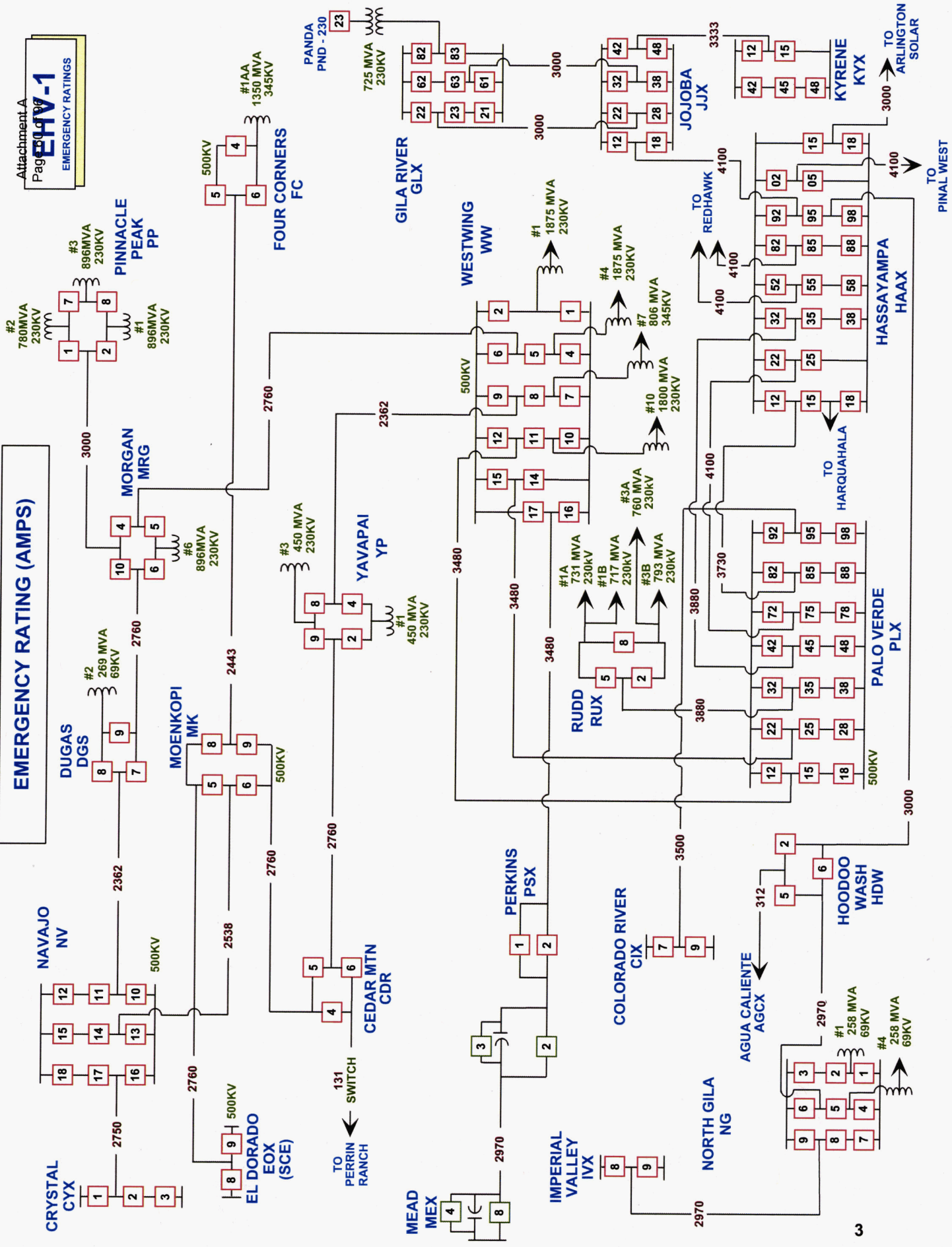
**LEGEND**  
**SYSTEM RATING MAPS**

<u><b>SYMBOL</b></u>	<u><b>DESCRIPTION</b></u>
	<b>CURRENT LIMIT IN AMPS</b> <b>LIMITING ELEMENT</b> <b>CONDUCTOR LIMIT IN AMPS</b>
	<b>TRANSFORMER LIMITS ARE IN MVA</b>
	<b>OVERHEAD TRANSMISSION LINE</b>
	<b>UNDERGROUND CABLE</b>
<b>M</b>	<b>MOTOR OPERATED SWITCH</b>
<b>V</b>	<b>VACCUM SWITCH</b>
<b>H</b>	<b>HYDRAULIC SWITCH</b>
	<b>BREAKER NUMBER</b>

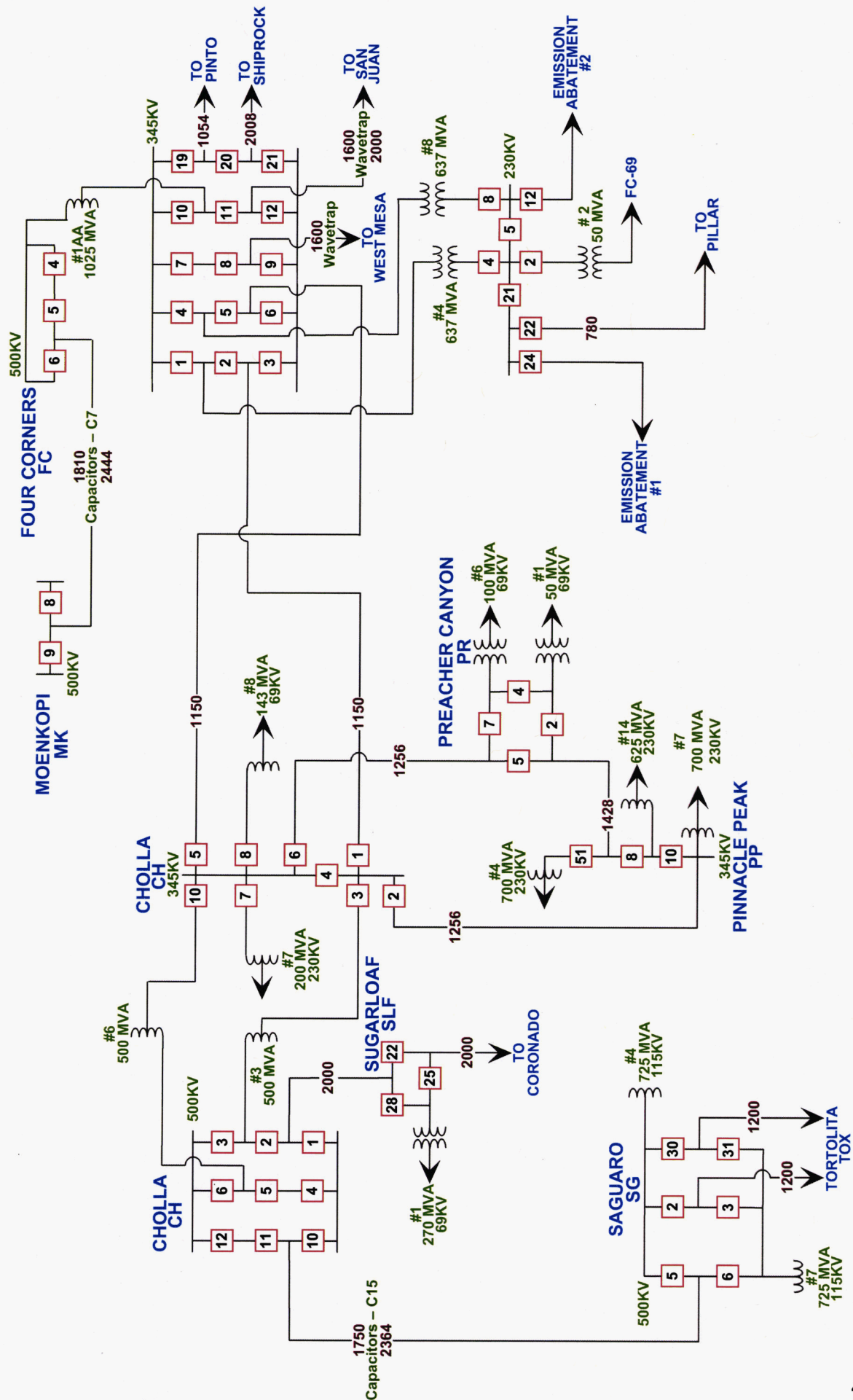




EMERGENCY RATING (AMPS)



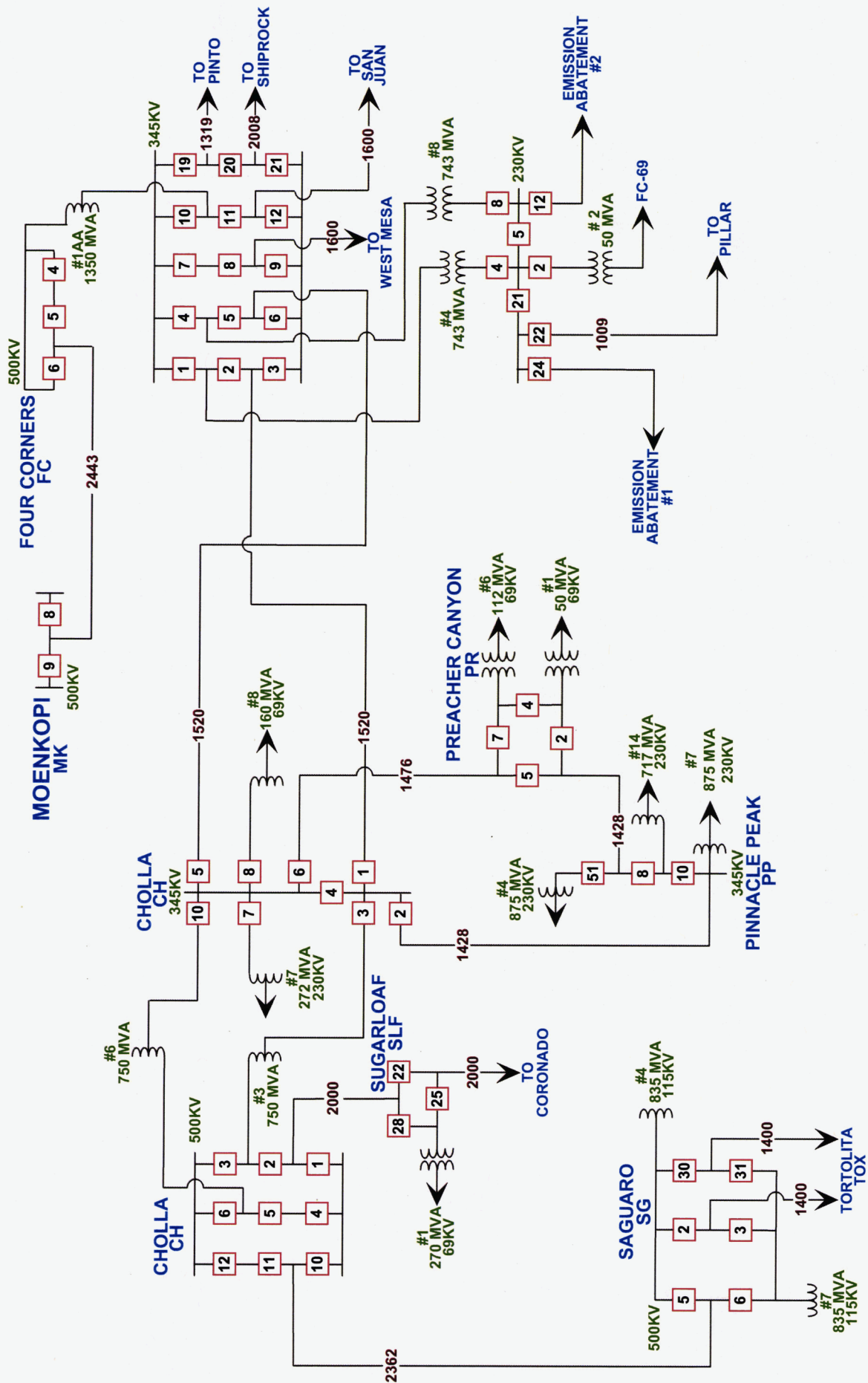
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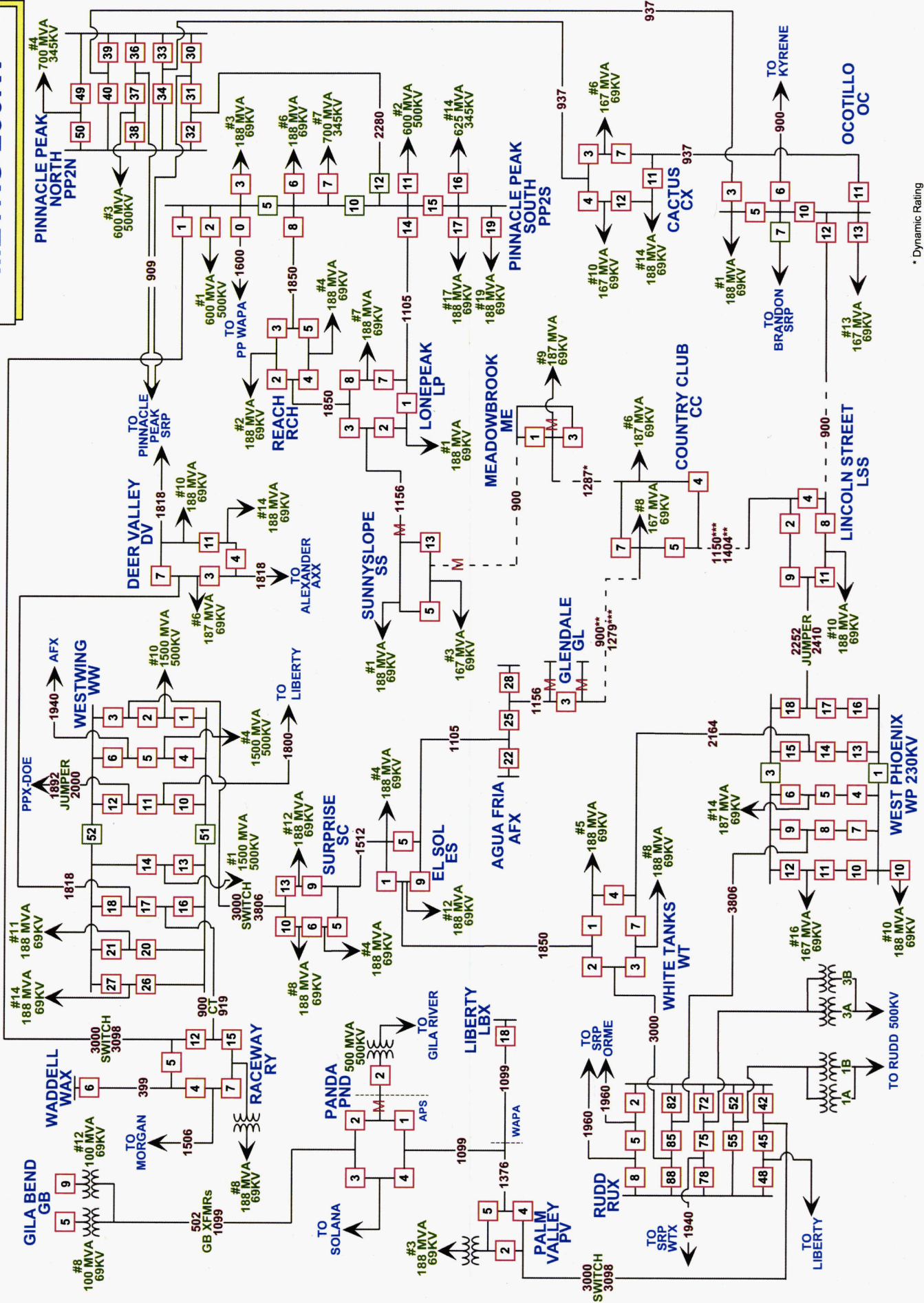


# EMERGENCY RATING (AMPS)

## EHV-2 EMERGENCY RATINGS



# METRO 230KV



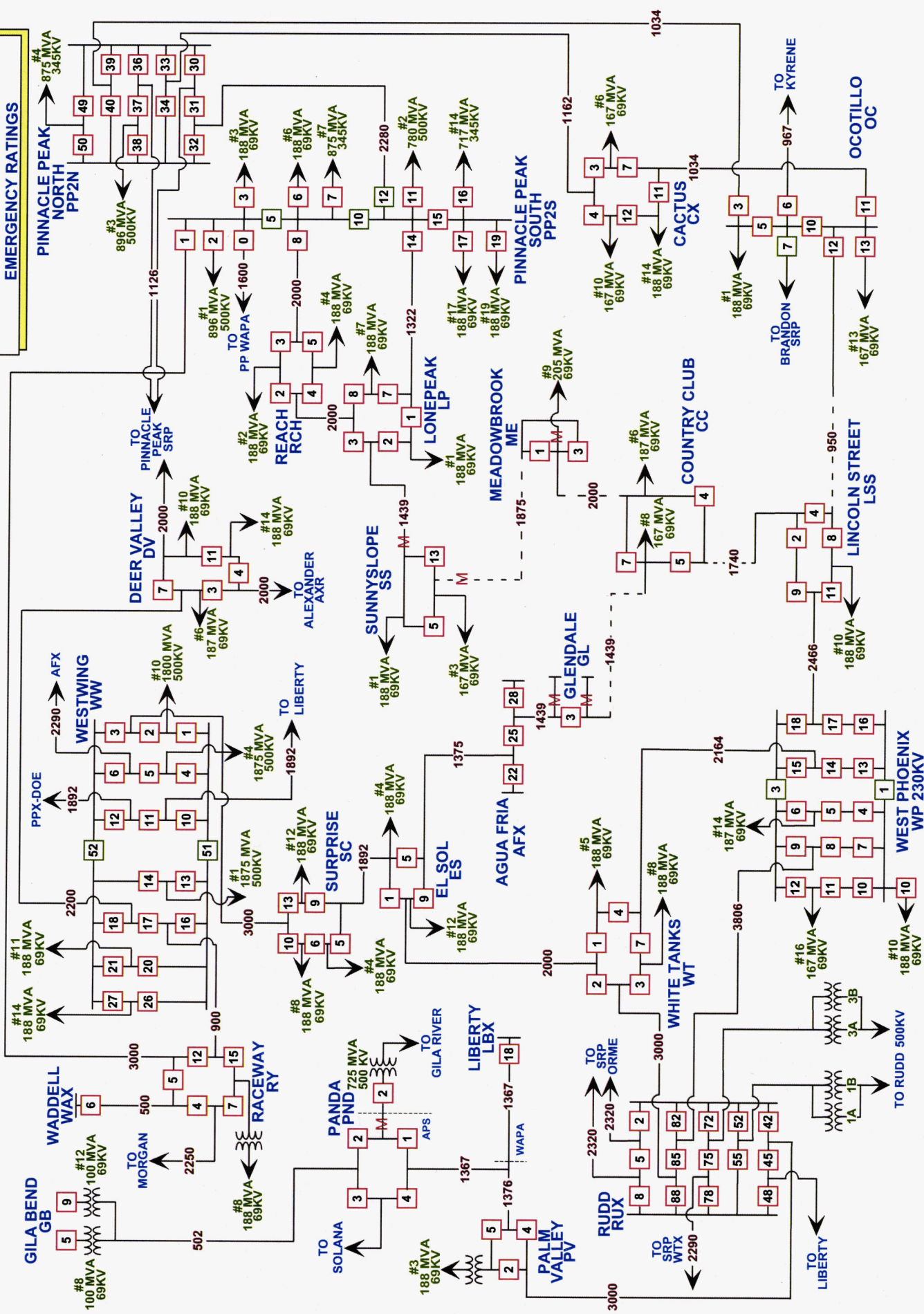
\* Dynamic Rating

\*\* No forced cooling on GT-CC, Cooling both ends LS-CC

\*\*\* Forced cooling on GT-CC, Cooling one end LS-CC



# METRO 230KV EMERGENCY RATINGS

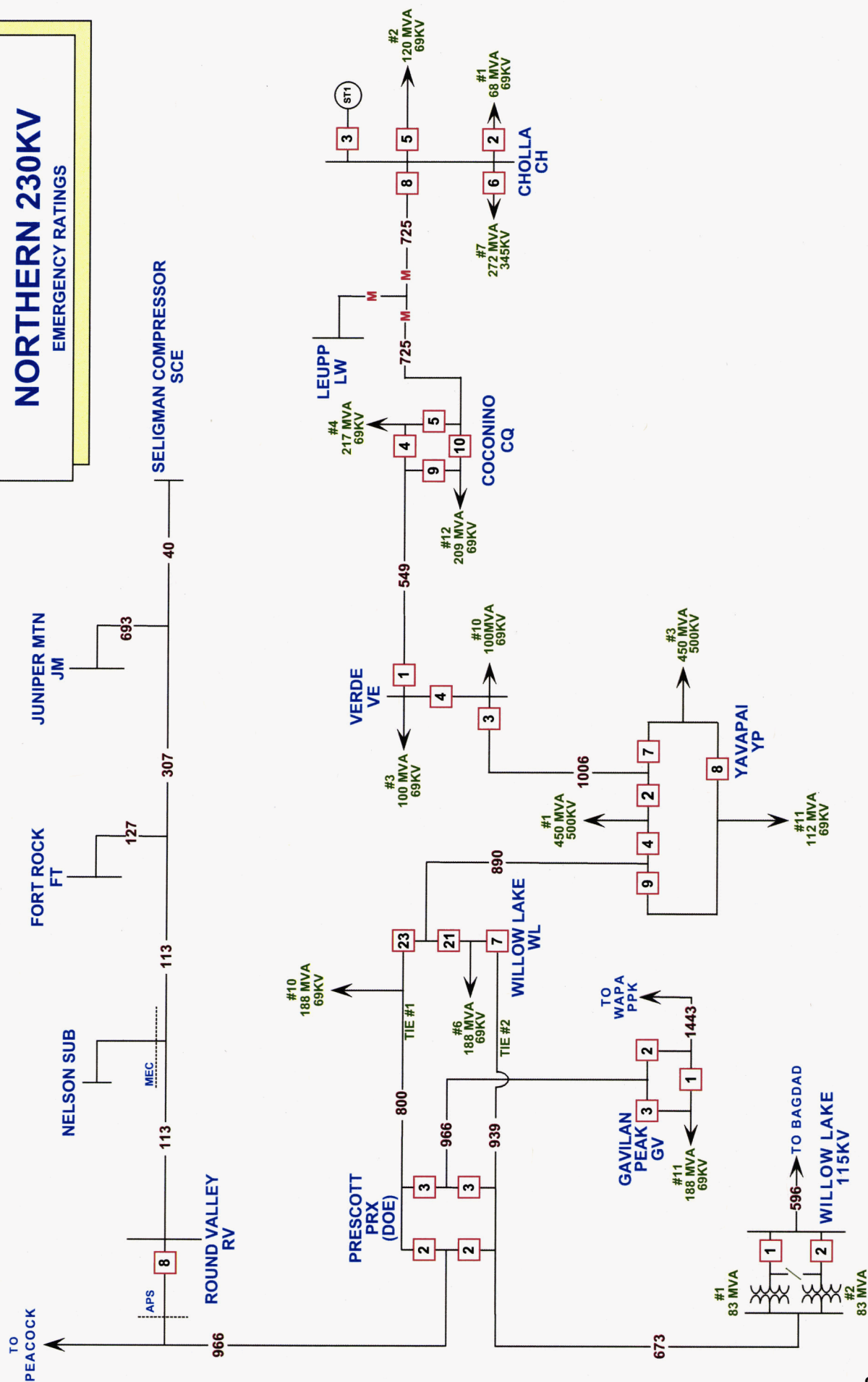




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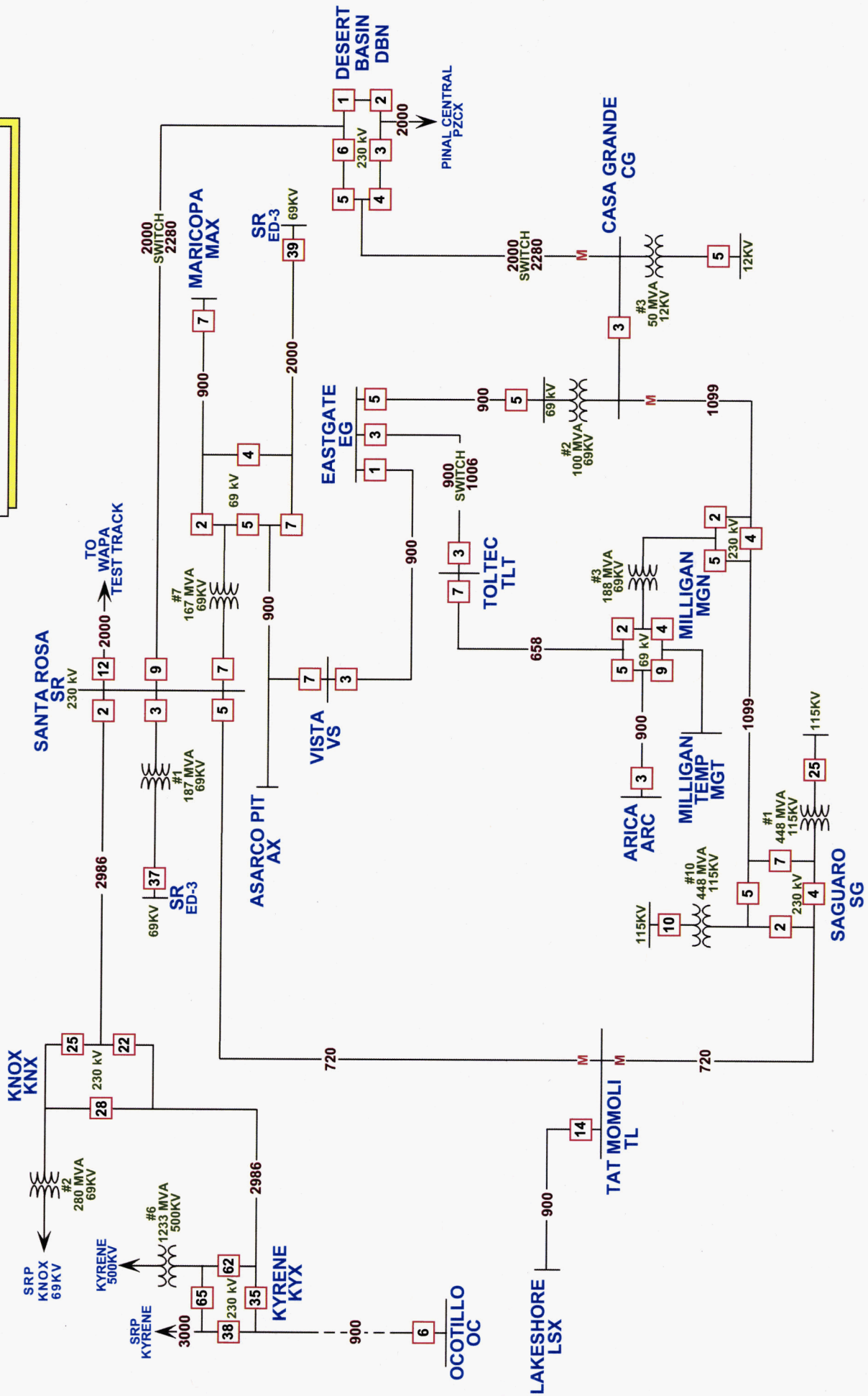
**NORTHERN 230KV**

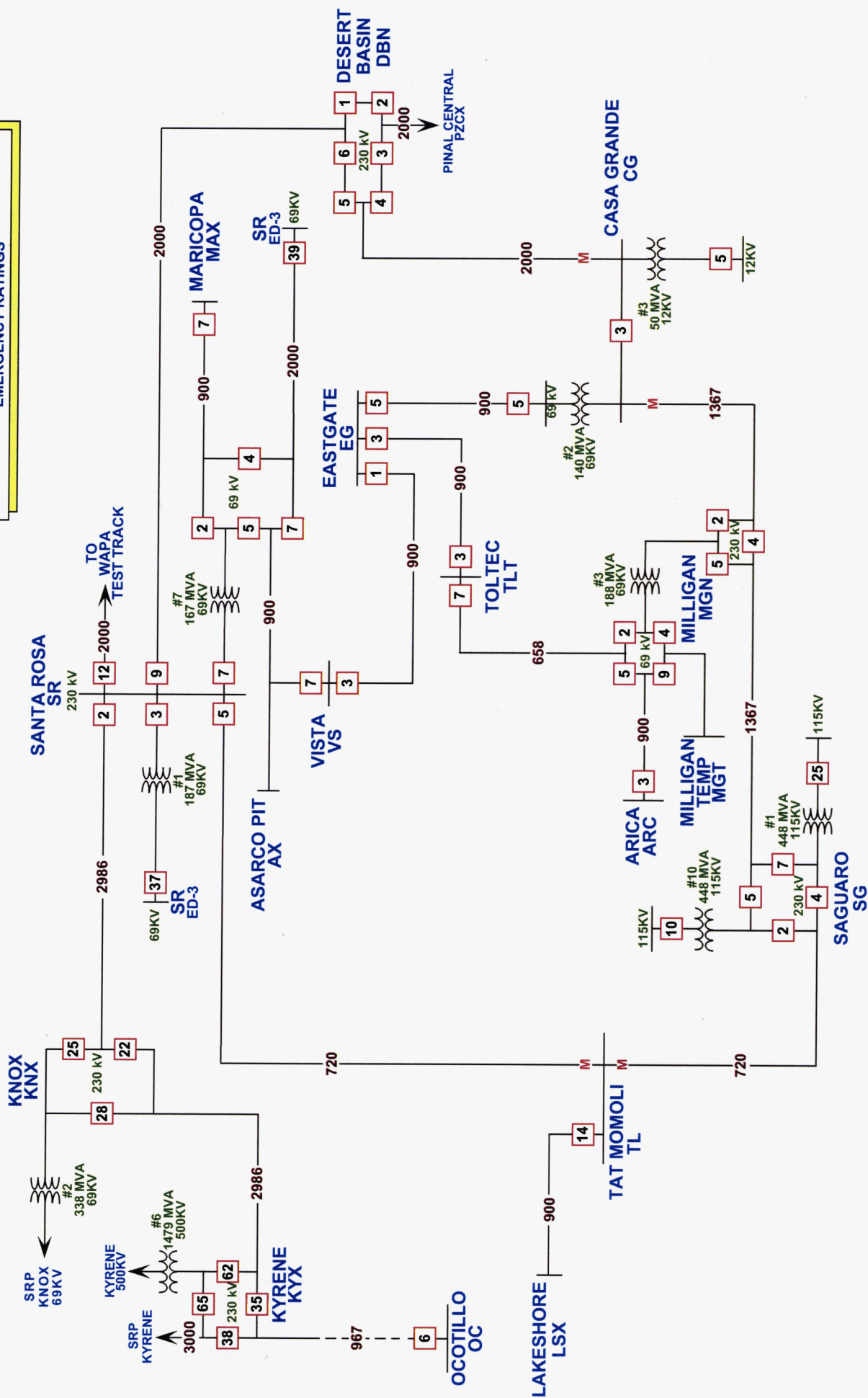
## EMERGENCY RATINGS





**SOUTHERN 230KV**







**ARIZONA PUBLIC SERVICE COMPANY**  
**TEN-YEAR TRANSMISSION SYSTEM PLAN**  
**2015 – 2024**  
**TECHNICAL STUDY REPORT**  
**FOR**  
**THE ARIZONA CORPORATION COMMISSION**

JANUARY 2015

## **Executive Summary**

Pursuant to North American Electric Reliability Corporation ("NERC") Standard TPL-001 "System Performance Under Normal (No Contingency) Conditions (Category A)", Arizona Public Service Company ("APS") performs annually a Category A analysis. The Category A analysis is performed for system conditions listed in Table I of the NERC/WECC Planning standards.

Results of the study indicate that, with the projects identified in APS's Ten-Year Transmission System Plan, APS is fully compliant with NERC Standard TPL-001.

Pursuant to NERC Standard TPL-002 "System Performance Following Loss of a Single Bulk Electric System Element (Category B)", APS performs annually a Category B contingency analysis. In Table I of the NERC/WECC planning standards, there are a total of four different Category B events that are to be studied each year to meet NERC Standard TPL-002.

A comprehensive list of contingencies was developed for the Category B contingency analysis and performed for the system conditions listed in Table I of the NERC/WECC Planning standards based on engineering judgment. APS believes that the selection of contingencies for inclusion in these studies, which is based on Category B of Table I of the NERC/WECC Planning standards, is acceptable to WECC. If requested by WECC, APS will implement measures to correct any deficiencies that have been identified by WECC.

Results of the study indicate that, with the projects identified in APS's Ten-Year Transmission System Plan, APS is fully compliant with NERC Standard TPL-002.

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**ARIZONA PUBLIC SERVICE COMPANY  
2015-2024  
TEN-YEAR TRANSMISSION SYSTEM PLAN  
TECHNICAL STUDY REPORT**

**Introduction**

This technical study report is performed and filed annually with the Arizona Corporation Commission ("Commission") pursuant to ARS § 40-360.02 and Decision No. 63876 (July 25, 2001). This report summarizes the results of power flow analyses and stability analyses for the Arizona Public Service Company ("APS") transmission system.

Power flow analyses were conducted for every year within the ten year planning window (2015-2024) and performed for two scenarios: (i) assumption that all transmission system elements are in service and within continuous ratings (Category A); and (ii) assumption of an outage on a single element, with all remaining system elements remaining within emergency ratings (Category B). Voltage deviations for these scenarios must also be within established guidelines. These voltage deviation guidelines closely approximate post-transient Volt Ampere Reactive ("VAR") margin requirements of the Western Electricity Coordinating Council ("WECC"). More detail is provided in APS's Transmission Planning Process and Guidelines, which is also included in the annual APS Ten-Year Transmission System Plan ("Ten-Year Plan") filing.

The stability analyses were performed to simulate electrical disturbances on the transmission system and evaluate the system response. The desired result is that all generators will remain on line, no additional lines will open, and the system oscillations will exhibit positive damping.

Results of the power flow and stability analyses aid in determining when and where new electrical facilities are needed because of reliability or security reasons. Additionally, some facilities are planned to address adequacy concerns. These include the interconnection of generation to the transmission system or efforts to increase import capability and/or export/scheduling capability to transmission-constrained or other areas.

**Base Case Development**

Power flow cases were created for each year of the 2015-2024 study time frame. These cases were developed from the latest available WECC heavy summer power flow cases.

The 2014 heavy summer operating case was chosen as the first seed case. This case was developed from a 2014 WECC heavy summer base case, and then updated in a coordinated effort between Arizona utilities, as well as the Imperial Irrigation District (IID), to include the sub-transmission and distribution models. This case was used as the seed case in the creation of the 2015-2018 power flow cases used for the power flow analyses performed for the 2015-2024 Ten-

Year Plan. Each intermediate case developed was updated with the forecasted loads and any system additions/upgrades that are planned in the respective year.

The second seed case chosen was the 2019 heavy summer power flow case that was developed through the SWAT sub-committee. In a collaborative effort, the Arizona utilities used the 2019 case to develop a 2019 summer case that included the sub-transmission and distribution systems of the Arizona utilities. This seed case was used to develop the 2020-2023 power flow cases. Each intermediate case developed was updated with the forecasted loads and any system additions/upgrades that are planned in the respective year.

The third and final seed case chosen was the 2024 heavy summer power flow case that was also developed through the SWAT sub-committee. This seed case was not used to develop any other power flow cases. In addition, the 2024 seed case was updated with the forecasted loads and any system additions/upgrades that were planned.

The forecasted loads modeled within all the power flow base cases include the effects of distributed renewable generation as well as energy efficiency programs. In addition, the forecasted loads are based on the most recent data at the time the cases were constructed<sup>1</sup>.

These cases represent the latest transmission and sub-transmission plans, load projections, and resource plans of utilities and independent power producers. By utilizing WECC base cases, all loads, resources, firm power transfers, and planned projects within the WECC system are represented. By using jointly developed seed cases the most accurate Arizona system and IID system are represented.

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<sup>1</sup> Load forecasts for the 2015-2024 TYP are based on APS load forecasts as of Q1 2014 that incorporate demand side management and energy efficiency, including distributed generation.

### **Power Flow Analyses**

APS performs analysis on base case and single contingency conditions to assess APS's system and neighboring systems. This analysis will determine any needs and timing for transmission additions and assess the impact of those additions on APS's system and neighboring systems. Various iterations of possible solutions lead to the final plans for transmission additions. The current APS planning practice is to include contingency analysis in the following regions:

- Arizona greater than 60kV including all generation - WECC model Area 14
  - APS, SRP, SWTC, TEP, WALC, Others<sup>2</sup>
- El Paso Electric 345kV and above - WECC model Area 11
- Imperial Irrigation District's system greater than 60kV - WECC model Area 21 or Area 8<sup>3</sup>
- Los Angeles Department of Water and Power greater than 100kV - WECC model Area 26
- Public Service Company of New Mexico 345kV and above - WECC model Area 10
- San Diego Gas & Electric greater than 90kV - WECC model Area 22
- Southern California Edison greater than 100kV - WECC model Area 24
- Southern Nevada (NV Energy) 345kV and above – WECC model Area 18
- Utah (Rocky Mountain Power) 345kV and above – WECC model Area 65 (PACE)
- WACM<sup>4</sup> 345kV and above - WECC model Area 73
- Mexico-CFE (Comision Federal Electricidad) greater than 100kV – WECC model Area 20

Due to the increase in monitored areas and the number of contingencies, the comprehensive lists of contingencies are not included in this report. However, they are available upon request by WECC or any other authorized stakeholder.

The APS system includes several reactive power resources that are used to maintain bus voltages within the limits defined by APS's Transmission Planning Process & Guidelines. These reactive power resources include shunt devices, series compensation, and tap changing transformers. APS also uses the reactive capabilities of its generators to assist in controlling system voltages. The reactive power resources are adequate and meet the system performance criteria.

APS does not have any additional existing or planned voltage or power flow control devices except those noted in the preceding paragraph. These devices exist outside the APS control area; however, they are not utilized or their operation is not necessary as a result of the contingencies in this study.

No planned outage of bulk electric equipment at APS occurs during the heavy summer peak time. Therefore, it is not necessary to study planned outages since this Ten-Year Plan study focuses on the heavy summer peak time.

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<sup>2</sup> Some local Load Serving Entities, such as local Electrical Districts, are also included in the expanded Arizona system model.

<sup>3</sup> Area 21 is IID's model included in WECC base cases. Area 8 is the more detailed version of IID's system model.

<sup>4</sup> Western Area Power Administration – Colorado Missouri



The transmission projects included in APS's Ten-Year plan are tabulated in a Security Needs Table and an Adequacy Needs Table, as shown below. These tables identify 9 transmission projects that are included in this Ten-Year Plan filing. Some of the projects were classified as Adequacy Needs because of the uncertainty of generation location, project size, and transmission availability in the later years. As projects near the five-year planning time frame, they may be redefined as Security Needs projects. For the projects included in the Security Needs Table, selected maps of the power flow simulations are contained in Appendix B showing the pre-project scenario (outage and resulting violation) and the post-project scenario (outage and no criteria violations). A summary of the power flow results is shown in Table 3.

**Table 1: Security Needs Table**

<b>Transmission Project</b>	<b>In Service Year</b>	<b>Critical Outage</b>	<b>Limiting Element/Condition</b>	<b>Map</b>
Palm Valley-TS2-Trilby Wash 230kV Line and Trilby Wash 230/69kV Substation	2015	Javelina – Surprise 69kV line	Overloads Surprise - Dysart 69kV line	B2-B3
Mazatzal 345/69kV Substation	2017	Preacher Canyon – Owens– Tonto 69kV line	Voltage deviations on the sub-transmission system in the area resulting in load shedding. Also overloads the Childs-Irving-Strawberry 69kV line.	B4-B5

**Table 2: Adequacy Needs Table**

<b>Transmission Project</b>	<b>In Service Year</b>	<b>System Benefits</b>
Hassayampa-North Gila 500kV #2 Line	2015	Increases import capability for the Yuma area and export/scheduling capability from the Palo Verde (PV) area to provide access to both solar and gas resources. Increases transmission system reliability and ability to deliver power from these resources.
Palo Verde-Delaney 500kV Line	2016	Increases the export scheduling capability from the PV area to provide access to both solar and gas resources. The project also provides for the interconnection of solar generation projects into the Delaney switchyard.
Delaney-Sun Valley 500kV Line	2016	Increases the import capability for the Phoenix Metropolitan area and export/scheduling capability from the PV area to provide access to both solar and gas resources. Along with the Sun Valley-Trilby Wash 230kV line, provides a new transmission source for power in the far north and west sides of the Phoenix Metropolitan transmission system.
Sun Valley-Trilby Wash 230kV Line	2016	Provides a second 230kV source for Trilby Wash so that it is not served as a radial substation, thereby increasing the local system reliability. With the 500kV source at Sun Valley, the project provides a new source for power in the far north and west sides of the Phoenix Metropolitan transmission system.
Ocotillo Modernization Project	2017	APS plans to modernize the Ocotillo Power Plant by retiring two 1960's-era steam generators and replacing them with five (5) quick-start natural Gas Turbines (GTs), and constructing associated 230kV transmission generation interconnections. The new generators will increase reliability in the Phoenix load center and upgrade Ocotillo's generation capabilities with advanced, high-efficiency technology.
Morgan- Sun Valley 500kV Line	2018	Increases import capability for the Phoenix Metropolitan area and export/scheduling capability from the PV area which includes both solar and gas resources. Increases transmission system reliability and ability to deliver power from these resources. Provides a second 500kV source for the Sun Valley substation. Provides support for multiple transmission corridor contingencies.
North Gila-Orchard 230kV Line	2018	Increases transmission system reliability and ability to distribute and deliver power within the Yuma area.

### Stability Analyses

A stability simulation for three-phase faults was performed for 2019 and 2024 for every non-radial 500kV and 345kV, and select 230kV lines that APS owns (totally or partially) or operates. It has been APS's experience that stability concerns do not manifest on the sub-transmission system, which is primarily designed to deliver power to load. Therefore, no simulations were performed at voltage levels less than 115kV, with the possible exception of generators or generator step up transformers at the generator substation. Additionally, every new proposed generation plant is required to perform stability evaluations prior to receiving permission to interconnect to the transmission system. A list of the transmission elements included in the stability analyses can be found in Appendices C and D.

Existing and planned protection systems are utilized in the study, including any backup or redundant system, and represent fault clearing times, the operation of the protection system, and the resulting removal of the facility that would occur as a result of the simulated event. Each simulation modeled a 3-phase bus fault, appropriate series capacitor flashing and reinsertion, fault removal, and transmission element removal. System performance was evaluated by monitoring representative generator rotor angles, bus voltages and system frequency. Plots of these system parameters are available upon request. The stability simulations performed to date indicate that no stability problems limit the transmission system.

### Category A & B Contingency Study Results

A high level overview of the results for the Category A and Category B contingencies is shown in Table 3 below. From this table, it is shown that each of the Category A and Category B contingencies meets the NERC/WECC Planning Standards.

**Table 3: Overview of Category A & B Standard Results**

NERC Planning Standards Category A		1-5 year Time Frame		6-10 year Time Frame	
		Case Years Studied	Standards Met?	Case Years Studied	Standards Met?
1	All Facilities in Service	2015 through 2019	Yes	2020 through 2024	Yes
NERC Planning Standards Category B		1-5 year Time Frame		6-10 year Time Frame	
		Case Years Studied	Standards Met?	Case Years Studied	Standards Met?
1	Loss of an Element without a Fault	2015 through 2019	Yes	2020 through 2024	Yes
2	3-Phase Fault with Normal Clearing – Generator	2019	Yes	2024	Yes
3	3-Phase Fault with Normal Clearing – Transmission Circuit	2019	Yes	2024	Yes
4	3-Phase Fault with Normal Clearing – Transformer	2019	Yes	2024	Yes

Table 3 is a high level summary that shows, with the projects listed in Tables 1 & 2, the APS system meets the performance criteria listed in NERC Standards TPL-001 and TPL-002. Due to the size of the transient stability, thermal power flow, and voltage steady state analyses, the detailed results are not included. However, they are available upon request by WECC or any other authorized stakeholder.

# APPENDIX A

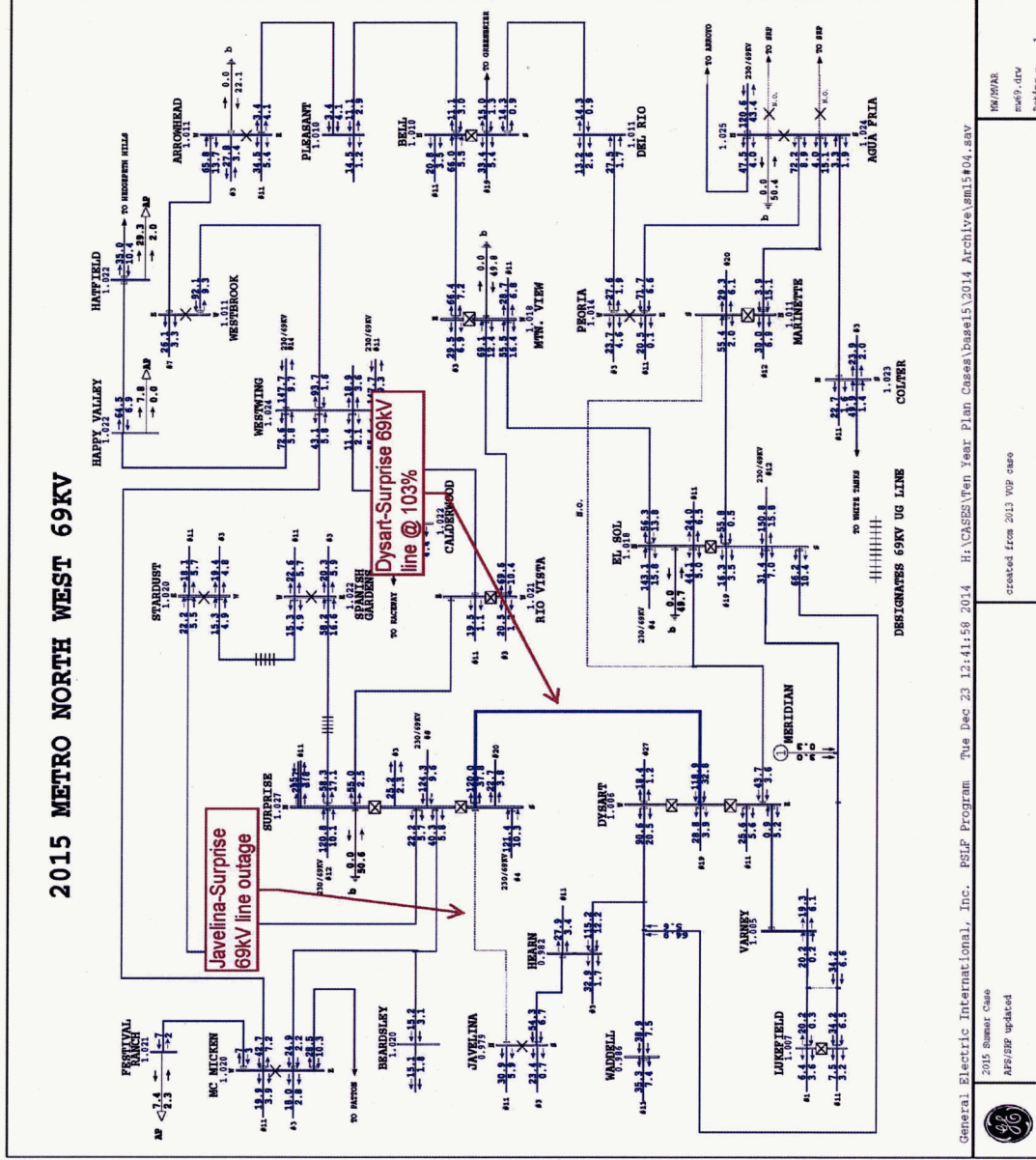
## Steady-State Contingency Lists

Available Upon Request

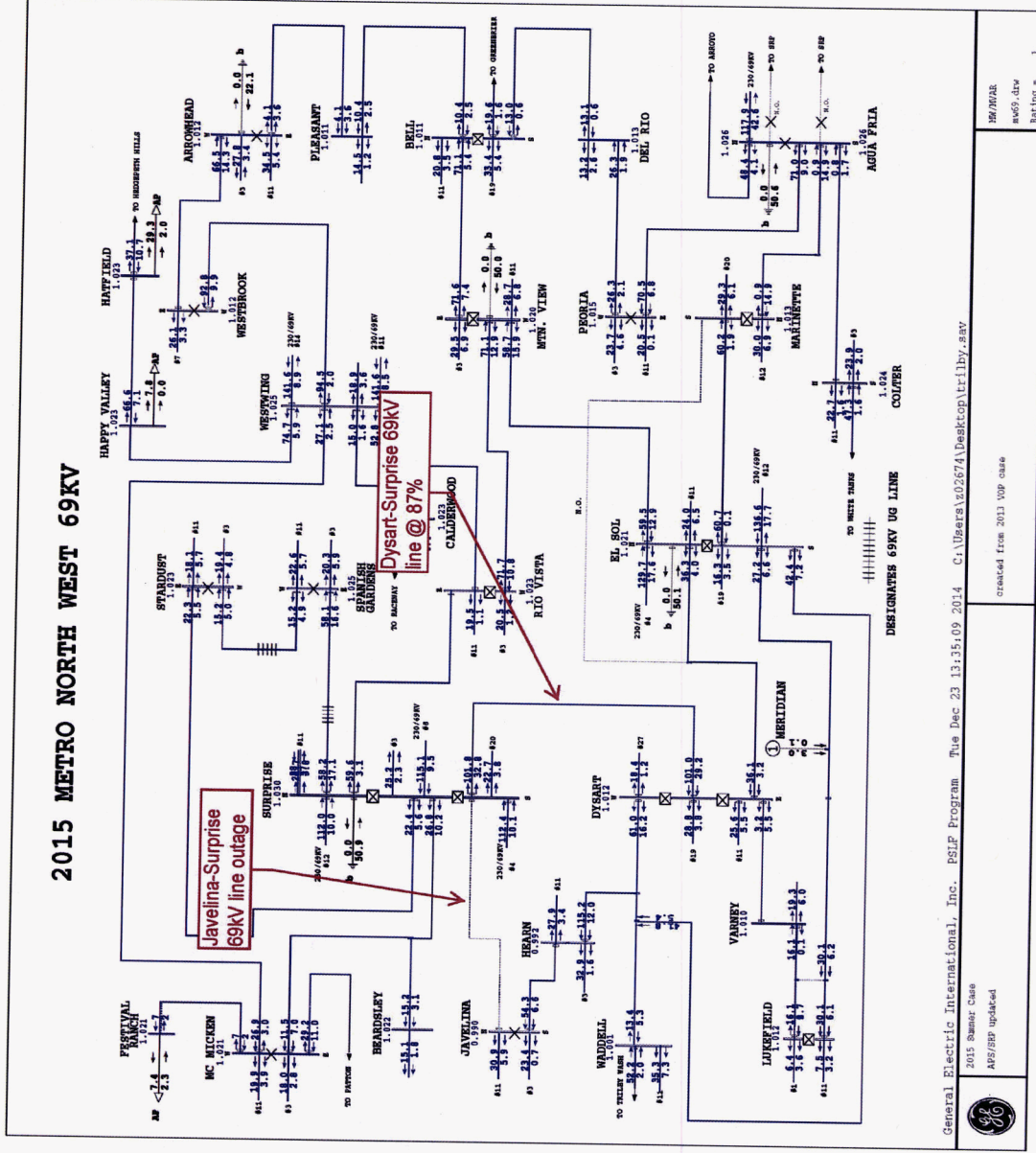
## APPENDIX B

### Power Flow Maps for Security Needs Projects

# Javelina - Surprise 69kV Outage without Trilby Wash 230/69kV Substation (2015)



# Javelina - Surprise 69kV Outage with Trilby Wash 230/69kV Substation (2015)









## APPENDIX C

### 2019 Transient Stability Contingency List

Transmission Circuits		
From	To	Voltage
Arlington	Hassyampa	500
Avery	Scatterwash	230
Avery	Raceway	230
Cedar Mountain	Yavapai	500
Cholla	Four Corners 1	345
Cholla	Four Corners 2	345
Cholla	Mazatzal	345
Cholla	Preacher Canyon	345
Cholla	Saguaro	500
Cholla	Sugarloaf	500
Colorado River	Palo Verde	500
Coronado	Sugarloaf	500
Coronado	Silverking	500
Coronado	Springerville	345
Crystal	Navajo	500
Country Club	Grand Terminal	230
Delany	Sun Valley	500
Dugas	Morgan	500
Dugas	Navajo	500
Four Corners	Moenkopi	500
Four Corners	San Juan	345
Gila River	Jojoba 1	500
Gila River	Jojoba 2	500
Gila River	Jojoba	230
Glen Canyon	Flagstaff 1	345
Glen Canyon	Flagstaff 2	345
Glendale	Grand Terminal	230
Hassyampa	Hoodoo Wash	500
Hassyampa	Jojoba	500
Hassyampa	North Gila	500
Hassyampa	Pinal West	500
Hoodoo Wash	North Gila	500
Jojoba	Kyrene	500
Jojoba	TS4	230
Kyrene	Browning	500
Liberty	Peacock	345

Moenkopi	Cedar Mountain	500
Moenkopi	El Dorado	500
Moenkopi	Yavapai	500
Morgan	Sun Valley	500
Morgan	Pinnacle Peak	500
Morgan	Westwing	500
Navajo	Moenkopi	500
Palm Valley	TS2	230
Palo Verde	Delany	500
Palo Verde	Devers	500
Palo Verde	Hassyampa 1	500
Palo Verde	Hassyampa 2	500
Palo Verde	Hassyampa 3	500
Palo Verde	Rudd	500
Palo Verde	Westwing 1	500
Palo Verde	Westwing 2	500
Pinnacle Peak	Flagstaff 1	345
Pinnacle Peak	Flagstaff 2	345
Pinnacle Peak	Mazatzal	345
Pinnacle Peak	Preacher Canyon	345
Pinnacle Peak	Reach	230
Pinnacle Peak	Lonepeak	230
Pinnacle Peak	Cactus	230
Pinnacle Peak	Ocotillo	230
Pinnacle Peak C	Pinnacle Peak E	230
Pinnacle Peak C	Pinnacle Peak W	230
Pinnacle Peak E	Pinnacle Peak N	230
Pinnacle Peak (SRP)	Pinnacle Peak 1 (APS)	230
Pinnacle Peak (SRP)	Pinnacle Peak 2 (APS)	230
Saguaro	Tortolita 1	500
Saguaro	Tortolita 2	500
Silverking	Browning	500
Sun Valley	Trilby Wash	230
Westwing	Perkins	500
Westwing	Yavapai	500
Westwing	Pinal West	345

<b>Transformers</b>		
<b>Bus</b>	<b>High</b>	<b>Low</b>
Cholla 1	500	345
Cholla 2	500	345
Cholla 1	345	230
Cholla 2	345	230
Four Corners 1	345	230
Four Corners 2	345	230
Four Corners	500	345
Gila River	500	230
Kyrene 6	500	230
Kyrene 7	500	230
Kyrene 8	500	230
Morgan	500	230
Pinnacle Peak 1	500	230
Pinnacle Peak 2	500	230
Pinnacle Peak 3	500	230
Pinnacle Peak 1	345	230
Pinnacle Peak 2	345	230
Pinnacle Peak 3	345	230
Pinnacle Peak 1 (WAPA)	345	230
Pinnacle Peak 2 (WAPA)	345	230
Pinnacle Peak 3 (WAPA)	345	230
Rudd 1	500	230
Rudd 2	500	230
Rudd 3	500	230
Rudd 4	500	230
Sun Valley 1	500	230
Westwing 1	500	230
Westwing 2	500	230
Westwing	500	345
Yavapai 1	500	230
Yavapai 2	500	230

<b>Generators</b>	
<b>Generator</b>	<b>Terminal Bus</b>
Cholla 4	22
Four Corners 5CC	22
Gila River ST1	18
Navajo 2	26
Ocotillo ST2	13.8
Palo Verde 1	24
Redhawk CT2 & ST1	18
Saguaro CT3	13.8
Sundance G3 & G4	13.8
West Phoenix North 5CT2	15
West Phoenix South CC1	13.8
Yucca CT3	13.8

**Plots provided upon request**



## APPENDIX D

### 2024 Transient Stability Contingency List

Transmission Circuits		
From	To	Voltage
Arlington	Hassiyampa	500
Avery	Scatterwash	230
Avery	Raceway	230
Cedar Mountain	Yavapai	500
Cholla	Four Corners 1	345
Cholla	Four Corners 2	345
Cholla	Mazatzal	345
Cholla	Preacher Canyon	345
Cholla	Saguaro	500
Cholla	Sugarloaf	500
Coronado	Sugarloaf	500
Coronado	Silverking	500
Coronado	Springerville	345
Crystal	Navajo	500
Country Club	Grand Terminal	230
Delany	Sun Valley	500
Devers	Palo Verde	500
Dugas	Morgan	500
Dugas	Navajo	500
Four Corners	Moenkopi	500
Four Corners	San Juan	345
Gila River	Jojoba 1	500
Gila River	Jojoba 2	500
Gila River	Jojoba	230
Glen Canyon	Flagstaff 1	345
Glen Canyon	Flagstaff 2	345
Glendale	Grand Terminal	230
Hassiyampa	Hoodoo Wash	500
Hassiyampa	Jojoba	500
Hassiyampa	North Gila	500
Hassiyampa	Palo Verde	500
Hassiyampa	Pinal West	500
Hoodoo Wash	North Gila	500
Jojoba	Kyrene	500
Jojoba	TS4/Liberty	230
Kyrene	Browning	500

Liberty	Peacock	345
Mazatzal	Pinnacle Peak	345
Moenkopi	Cedar Mountain	500
Moenkopi	El Dorado	500
Moenkopi	Yavapai	500
Morgan	Sun Valley	500
Morgan	Pinnacle Peak	500
Morgan	Westwing	500
Navajo	Moenkopi	500
Palm Valley	TS2/Trilby Wash	230
Palo Verde	Delany	500
Palo Verde	Devers	500
Palo Verde	Hassyampa 1	500
Palo Verde	Hassyampa 2	500
Palo Verde	Hassyampa 3	500
Palo Verde	Rudd	500
Palo Verde	Westwing 1	500
Palo Verde	Westwing 2	500
Pinnacle Peak	Flagstaff 1	345
Pinnacle Peak	Flagstaff 2	345
Pinnacle Peak	Mazatzal	345
Pinnacle Peak	Preacher Canyon	345
Pinnacle Peak	Reach	230
Pinnacle Peak	Lonepeak	230
Pinnacle Peak	Cactus	230
Pinnacle Peak	Ocotillo	230
Pinnacle Peak C	Pinnacle Peak E	230
Pinnacle Peak C	Pinnacle Peak W	230
Pinnacle Peak E	Pinnacle Peak N	230
Pinnacle Peak (SRP)	Pinnacle Peak 1 (APS)	230
Pinnacle Peak (SRP)	Pinnacle Peak 2 (APS)	230
Saguaro	Tortolita 1	500
Saguaro	Tortolita 2	500
Silverking	Browning	500
Sun Valley	Trilby Wash	230
Westwing	Perkins	500
Westwing	Yavapai	500
Westwing	Pinal West	345

<b>Transformers</b>		
<b>Bus</b>	<b>High</b>	<b>Low</b>
Cholla 1	500	345
Cholla 2	500	345
Cholla 1	345	230
Cholla 2	345	230
Four Corners 1	345	230
Four Corners 2	345	230
Four Corners	500	345
Gila River	500	230
Kyrene 6	500	230
Kyrene 7	500	230
Kyrene 8	500	230
Morgan	500	230
Pinnacle Peak 1	500	230
Pinnacle Peak 2	500	230
Pinnacle Peak 3	500	230
Pinnacle Peak 1	345	230
Pinnacle Peak 2	345	230
Pinnacle Peak 3	345	230
Pinnacle Peak 1 (WAPA)	345	230
Pinnacle Peak 2 (WAPA)	345	230
Pinnacle Peak 3 (WAPA)	345	230
Rudd 1	500	230
Rudd 2	500	230
Rudd 3	500	230
Rudd 4	500	230
Sun Valley 1	500	230
Westwing 1	500	230
Westwing 2	500	230
Westwing	500	345
Yavapai 1	500	230
Yavapai 2	500	230

<b>Generators</b>	
<b>Generator</b>	<b>Terminal Bus</b>
Cholla 4	22
Four Corners 5CC	22
Gila River ST1	18
Navajo 2	26
Ocotillo ST2	13.8
Palo Verde 1	24
Redhawk CT2 & ST1	18
Saguaro CT3	13.8
Sundance G3 & G4	13.8
West Phoenix North 5CT2	15
West Phoenix South CC1	13.8
Yucca CT3	13.8

**Plots provided upon request**

# Attachment B

## **Arizona Public Service Company Renewable Transmission Action Plan January 2015**

In the Fifth Biennial Transmission Assessment ("BTA") Decision, (Decision No. 70635, December 11, 2008), the Arizona Corporation Commission ("ACC" or "Commission") ordered Arizona Public Service Company ("APS" or "Company") to file a document identifying their top potential Renewable Transmission Projects ("RTPs") that would support the growth of renewable resources in Arizona. As such, on January 29, 2010, APS filed with the Commission its top potential RTPs, which were identified in collaboration with Southwest Area Transmission planning group ("SWAT") and its subgroups, other utilities and stakeholders. In its filing, APS included a Renewable Transmission Action Plan ("RTAP"), which included the method used to identify RTPs, project approval and financing of the RTPs.

On January 6, 2011, the Commission approved APS's RTAP (Decision No. 72057, January 6, 2011<sup>1</sup>), which allows APS to pursue the development steps indicated in the APS RTAP. The Decision, in part, ordered:

*IT IS FURTHER ORDERED that the timing of the next Renewable Transmission Action Plan filing shall be in parallel with the 2012 Biennial Transmission Assessment process.*

*IT IS FURTHER ORDERED that Arizona Public Service Company shall, in any future Renewable Transmission Action Plans filed with the Commission, identify Renewable Transmission Projects, which include the acquisition of transmission capacity, such as, but not limited to, (i) new transmission line(s), (ii) upgrade(s) of existing line(s), or (iii) the development of transmission project(s) previously identified by the utility (whether conceptual, planned, committed and/or existing), all of which provide either:*

- 1. Additional direct transmission infrastructure providing access to areas within the state of Arizona that have renewable energy resources, as defined by the Commission's Renewable Energy Standard Rules (A.A.C. R14-2-1801, et seq.), or are likely to have renewable energy resources; or*
- 2. Additional transmission facilities that enable renewable resources to be delivered to load centers.*

Renewable expansion in the APS service territory (solar) has been trending toward the development of smaller scale renewable projects. APS has received many interconnection requests for these smaller solar projects, which interconnect directly into the local distribution system (69kV or below) rather than APS's high voltage transmission system. Additionally, APS has received only a few transmission system interconnection requests within the last two years.

The APS 2015-2024 Ten-Year Transmission System Plan does not show a need for additional RTPs beyond what the Commission previously approved in Decision No. 72057. As a result, in this RTAP, APS is not proposing new RTPs. APS will explore new renewable transmission opportunities when appropriate.

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<sup>1</sup> Commission Decision No. 72057 found that APS's 2010 RTAP process and Plan is appropriate and consistent with the Commissions' Fifth Biennial Transmission Assessment final order.



## **Arizona Public Service Company Renewable Transmission Action Plan January 2015**

The RTPs that APS filed in its original RTAP continue to be viable and will be developed as reliability and resource needs arise. The following section describes the RTPs (approved by the Commission in Decision No. 72057), the expected cost for each, and the current status of each RTP.

### **1. Proposed development plan for a Delaney to Palo Verde 500kV project**

Description: This project is one section of the Palo Verde to Sun Valley 500kV transmission line project that APS will need to import various generation resources to the Phoenix area load center. It is an integral piece to APS's 500kV infrastructure backbone in the greater Phoenix area. It also is an important component to the potential Devers II<sup>2</sup> transmission project as the project establishes the Delaney switchyard. The Delaney switchyard has been identified as the starting point for the Devers II transmission project, which would provide a connection to the Southern California markets, and has the potential to enable additional renewable energy to be exported from Arizona to California.

Expected Cost: APS estimates the Company's portion of the project to cost approximately \$60 million.

Current Status: APS acquired a Certificate of Environmental Compatibility ("CEC") for the project (Decision No. 68063, August 17, 2005). APS has almost completed the land and right-of-way acquisition, design, and engineering for the project. Construction at the Delaney switchyard is in progress. Also, APS is proceeding with engineering and construction of the new bay at the Palo Verde switchyard. The 2015 Ten-Year Plan shows an in-service date of 2016 to coincide with APS's need date for Sun Valley.

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<sup>2</sup> The Devers II project is now called Delaney to Colorado River (DCR).

**Arizona Public Service Company  
Renewable Transmission Action Plan  
January 2015**

**2. Proposed development plan for a Palo Verde to North Gila 500kV #2 project**

Description: The Palo Verde to North Gila transmission project is a 500kV transmission line from the Palo Verde hub area to the North Gila Substation, which is located outside of Yuma. This project helps serve the Yuma area as it will increase APS's ability to deliver various resources and increase APS's load serving capability to the load center in Yuma. The area along the line has excellent solar conditions, which should result in comparably good pricing of solar resources. This line could also enable APS to bring additional geothermal resources to APS customers from Imperial Valley in California as well as provide an opportunity for Arizona to export renewable energy as pricing/opportunity permit.

Estimated Cost: APS estimates the Company's portion of the project to cost approximately \$160 million.

Current Status: APS has acquired a CEC for the project in Commission Decision No. 70127 (January 23, 2008). APS has completed the land and right-of-way acquisition, design, and engineering for the project. Material acquisition and construction activities began in mid-2013, and the line is expected to be in service in Spring 2015. APS and the Imperial Irrigation District ("IID") are joint participants in this project.

**3. Proposed development plan for a Palo Verde to Liberty and Gila Bend to Liberty projects**

Description: The Palo Verde to Liberty and Gila Bend to Liberty are conceptual 500kV transmission line projects from the Palo Verde hub and from the Gila Bend/Gila River area to a new substation near the existing Liberty substation located in the west valley.

Current Status: The APS 2015 Ten-Year Plan Study does not currently show a need for these projects and, as a result, no further progress on the development plan has been made. This is primarily due to the previous downturn in the economy and a slowdown of renewable energy development in the area. APS will revisit these projects when appropriate.